# OPERATING & SERVICE MANUAL

# 10811A/B Quartz Crystal Oscillator

General Information
Installation
Operation
Performance Tests
Adjustments
Replaceable Parts
Manual Changes
Service

HEWLETT PACKARD

# 10811A/B
# QUARTZ CRYSTAL OSCILLATOR

OPERATING AND SERVICE MANUAL

**SERIAL PREFIX:** 2028

This manual applies to Hewlett-Packard Model *10811A/B* Oscillators with serial prefix number 2028.

Also covers oscillators with HP Part Numbers 10811-60101 and 10811-60105.

**OTHER SERIAL PREFIXES**

For serial prefixes above 2028, a "Manual Change" sheet is included with this manual.

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MANUAL PART NUMBER 10811-90002 Microfiche Part Number 10811-90003

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# PREFACE

This manual is designed to present the information required by the user to effectively operate and maintain the 10811A/B Quartz Crystal Oscillator.

In limiting the depth of coverage of this manual, a certain amount of previous knowledge on the part of the reader must be assumed. A variety of additional related documentation is available. These materials address the specific areas of interest, and should be used whenever necessary to supplement this manual. Users unfamiliar with precision time keeping and frequency standards, for example, may wish to refer to the 10811A/B Documentation Map for further information.

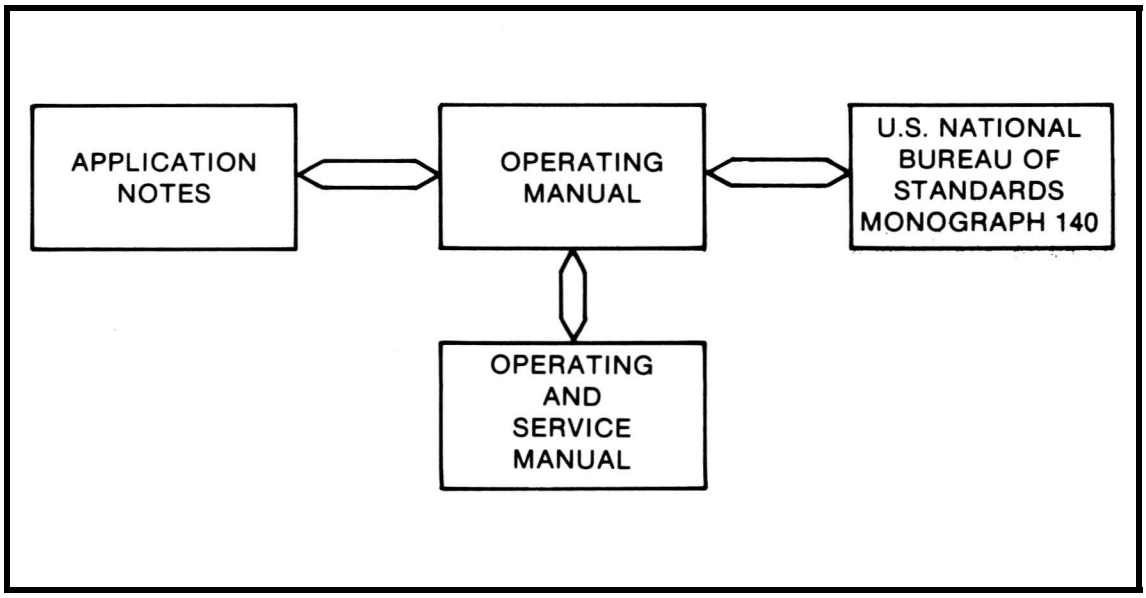
The following references can provide additional information about the theory and use of precision frequency sources and quartz oscillators.

1. Application Note 52-1 Hewlett-Packard Fundamentals of Time and Frequency Standards.
2. Application Note 52-2 Hewlett-Packard Time Keeping and Frequency Calibration.
3. Application Note 200-2 Hewlett-Packard Fundamentals of Quartz Oscillators.
4. ~~U.S. National Bureau of Standards, Monograph 140, Time and Frequency Theory and Fundamentals available from:~~

   ~~Superintendent of Documents~~
   ~~U. S. Government Printing Office~~
   ~~Washington, D.C. 20402~~

5. In 1990 the NIST replaced the Monograph 140 document with this interim collection of documents NIST/TN1-339 or visit time NIST Time and Frequency Publication Database.

The 10811A/B Quartz Crystal Oscillator has two manuals available. The Operating Instruction Manual is supplied with the oscillator and is intended for the user that desires only operating information. The Operating and Service Manual is a complete document containing both operating and servicing information. The Operating and Service Manual (This manual) is not supplied with the oscillator, but is available by ordering HP Part No. 10811-90002 (of course they won't sell you one). The Operating Instructions Manual is a duplication of Sections I, II, and III of the Operating and Service Manual. Any references in the Operating Instructions Manual to Sections IV, V, VI, VII, and VIII should be considered references to the Operating and Service Manual.




**10811A/B Documentation Map**

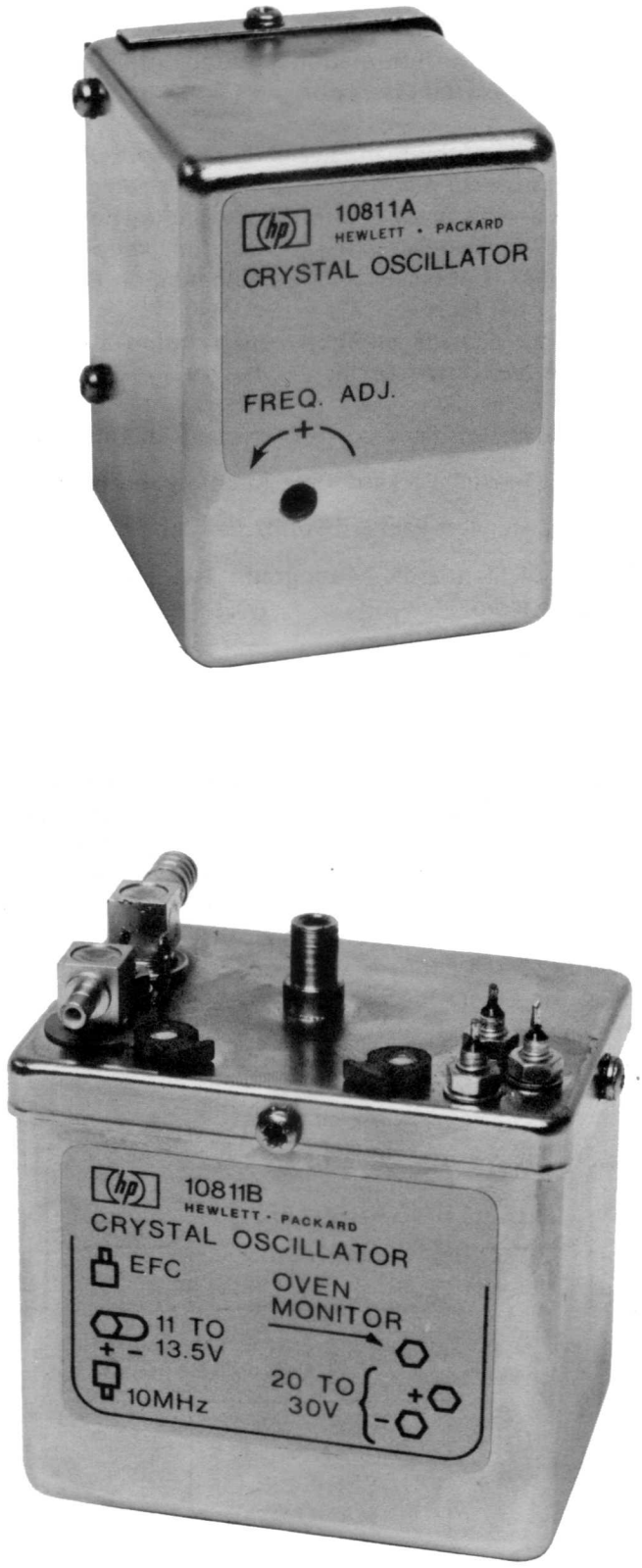



**Figure 1-1. 10811A and 108118 Oscillators**

SECTION I

# GENERAL INFORMATION

## 1-1. INTRODUCTION

1-2. This manual provides information pertaining to the installation, operation, testing, adjustment, and maintenance of the HP Model 10811A/B Quartz Crystal Oscillator. *Figure 1-1* shows the 10811A and 10811B.

1-3. This manual is divided into eight sections, each covering a particular topic. The topics by section number are shown below. Sections I, II, III appear in the Operating Instructions Manual. Sections I through VIII appear in the Operating and Service Manual.

| Section | Topic |
|---|---|
| I | General Information |
| II | Installation |
| III | Operation |
| IV | Performance Tests |
| V | Adjustments |
| VI | Replaceable Parts |
| VII | Manual Changes |
| VIII | Service |

## 1-4. SPECIFICATIONS

1-5. Specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the oscillator may be tested.

## 1-6. SAFETY CONSIDERATIONS

1-7. The Model 10811A/B Component Oscillator is a Safety Class III product and must be powered from a source which is electrically isolated from the mains (line circuits). Safety information pertinent to the operation and servicing of this instrument is included in the appropriate sections of this manual.

## 1-8. INSTRUMENTS COVERED BY THIS MANUAL

1-9. Attached to the instrument is a serial number plate. The serial number is in the form 0000A00000. It is in two parts; the first four digits and the letter are the serial prefix and the last five are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under Serial Prefix on the title page.

1-10. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different than those described in this manual. The manual for this new instrument is accompanied by a yellow Manual Changes supplement. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

1-11. In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

| Averaging Time $\tau$ \|seconds\| | Stability $\sigma_y(\tau)$ |
|---|---|
| $10^{-3}$ | $1.5 \times 10^{-10}$ |
| $10^{-2}$ | $1.5 \times 10^{-11}$ |
| $10^{-1}$ | $5 \times 10^{-12}$ |
| $10^{0}$ | $5 \times 10^{-12}$ |
| $10^{1}$ | $5 \times 10^{-12}$ |
| $10^{2}$ | $1 \times 10^{-11}$ |

| Offset from Signal f [Hz] | Phase Noise Ratio $\mathcal{L}(f)$ [dBc] |
|---|---|
| $10^{0}$ | -90 |
| $10^{1}$ | -120 |
| $10^{2}$ | -140 |
| $10^{3}$ | -157 |
| $10^{4}$ | -160 |

**Table 1-1. Specifications Table**

## Frequency Stability: (See Definition of Terms)

**Long Term (Aging Rate)**: <5 X $10^{-10}$/day after 24-hour warm-up. See Note 1.
<1 X $10^{-7}$/year for continuous operation.
**Short Term**: Refer to tables and figures above.

## Environmental Sensitivity:

**Temperature**: <4.5 X 10-9 over a -55°C to 71°C range. <2.5 X $10^{-9}$ over a O°C to 71 °c range.
**Operating**:-55°C to +71 °C.
**Storage:** -55°C to X85°C.
**Load**: <5 X $10^{-10}$ for a ±10% change in 50 ohm load. <5 X $10^{-10}$ for a ±25% change in 1KΩ load.

## Power Supplies:

**Oscillator Supply**: <2 X $10^{-10}$ for 1% change. <100µv ripple and noise required.
**Oven Supply:** <1 X $10^{-10}$ for 10% change. <30 mv ripple and noise required.
**Gravitational Field**: <4 X $10^{-9}$ for 2g static shift (turn-over).
**Magnetic Field**: <-90 dBc sidebands due to 0.1 millitesla (1 Gauss) rms at 100 Hz.
**Humidity (typical):** 1 X $10^{-9}$ for 95% RH at 40°C.
**Shock (survival):** 30g, 11ms, ½ sinewave**.**
Altitude (typical): 2 X 10-9 for 0 to 50,000 ft.

**Warmup**
10 min. after turn-on within 5 X 10-9 of final value, at 25°C and 20 Vdc. See Notes 1 & 2.

## Adjustment

**Coarse Frequency Range**: >±1 X $10^{-6}$ (± 10 Hz) with 18 turn control.
**Elec. Frequency Control (EFC)**: ≥1 X $10^{-7}$ (1 Hz) total, control range -5 Vdc to +5 Vdc.

## Output

**Frequency:** 10 MHz
**Voltage**: 0.55 ± 0.05 V rms into 50 ohm. 1V rms ±20%, into 1K ohm.
**Harmonic Distortion**: Down more than 25 dB from output.
**Spurious Phase Modulation**: Down more than 100 dB from output (discrete sidebands 10 Hz to 25 kHz).

## Power Requirements

**Oscillator Circuit:** 11.0 to 13.5 Vdc. 30 mA typical. 40 mA max.
**Oven Circuit:** 20 to 30 V dc; turn on load is 42 ohm minimum. Steady-state power drops to a typical value of 2.0W at 25°C in still air with 20 Vdc applied.

## Connectors

10811A: Mates with CINCH 50-30S-30 (HP 1251-0160) , Vishay/Dale (HP 1251-2035) EB81-BN15TGW, EDAC 305-030-500-202 or 357-030-520-202 or equivalent (not supplied).
10811B: Solder terminals and SMB Snap-on connectors. Mates with Cablewave Systems, Inc. #700156 or equivalent (not supplied).

## Accessories Available:

**Service Manual**: HP 10811-90002: (not supplied). This Manual.
**Size**:
72 mm X 52 mm X 62 mm, (see Figure 1). (2-13/16" X 2-1/32" X 2-7/16", 14 cu. in.).

## Weight: 0.31 kg (11 oz.)

## Definition of Terms

**Long-Term Frequency Stability** is defined as the absolute value (magnitude) of the fractional frequency change with time. An observation time sufficiently long to reduce the effects of random noise to an insignificant value is implied. Frequency changes due to environmental effects must be considered separately.

**Time Domain Stability** $\sigma_y(\tau)$ (Allan deviation) is defined as the two-sample deviation of fractional frequency fluctuations due to random noise in the oscillator. The measurement bandwidth is 100 kHz.

**Frequency Domain Stability** is defined as the single sideband phase noise-to-signal ratio per Hertz of bandwidth (a power spectral density). This ratio is analogous to a spectrum analyzer display of the carrier versus either phase modulation sideband.
See "NBS-Monograph 140" for measurement details.

## Notes:

1. For oscillator off-time less than 24 hours.
2. Final value is defined as frequency 24 hours after turn-on.

*Specifications describe the instrument's warranted performance. Supplemental characteristics are intended to provide information useful in applying the instrument by giving TYPICAL or NOMINAL, but non warranted performance parameters. Definition of terms is provided at the end of the specification section.

1-12. For information concerning a serial prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

## *1-13. DESCRIPTION*

1-14. The HP Model 10811A/B Quartz Crystal Oscillator is an extremely stable, compact, low power source of 10 MHz. The 10811A/B has a very fast warm-up time, exhibits excellent temperature characteristics and has low phase noise and power consumption.

1-15. The 10811A/B has the ability to be adjusted over a range of 20 Hz ($2 \times 10^{-6}$), yet the control is sensitive enough to allow adjustment to better than 0.1 Hz ($1 \times 10^{-8}$). The frequency can also be controlled electronically over a 1 Hz ($1 \times 10^{-7}$) range with an externally applied voltage to the EFC.

1-16 The 10811A/B is field repairable, thus allowing the oscillator to be quickly placed back into service.

1-17. The 10811A/B requires two external power supplies. The power supply requirements are listed in Section II.

1-18. The 10811A and 10811B are identical, except for the connections. The 10811A uses a standard 15 pin printed circuit connector. The 10811B uses filtered-feedthrough terminals for power and oven monitor, and SMB subminiature rf snap-on connections for the 10 MHz output and EFC.

## 1-19. HP Part Number 10811-60101 and 10811-60105

1-20. The 10811-60101 is a 10811A in which phase noise, magnetic field and 2g turn-over are not specified. The 10811-60101 is physically identical to the 10811A.

1-21. The 10811-60105 is a 10811-60101 with specifications of $<1.5 \times 10^{-9}$ for aging and $<1 \times 10^{-11}$ for short-term stability for a 1-second averaging time. The 10811-60105 is physically identical to the 10811A.

## *1-22. RECOMMENDED TEST EQUIPMENT*

1-23. The test equipment required to maintain the Model 10811A/B is listed in Table 1-2. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

**Table 1-2. Recommended Test Equipment**

| | INSTRUMENT | REQUIRED CHARACTERISTICS | MODEL NO. |
|---|---|---|---|
| 1. | Frequency Analyzer* | Phase noise measurement at 10 MHz 5390 cannot measure 10811 specs above 10 Hz | 5390A* |
| 2. | Frequency Counter** | 10 MHz range, HP-IB programmable, 2 ns resolution | 5345A** |
| 3. | Computing Controller** | HP-IB compatible | 9835A or 9825A ** |
| 4. | Frequency Reference | Short term stability ≤$5x10^{-12}$/second Long term stability <$5x10^{-10}$/day | 5065A, 5061A (Option 004), or 105A/B*** |
| 5. | Sampling Voltmeter | ±3% accuracy at 10 MHz | 3406A |
| 6. | General Purpose Oscilloscope | Bandwidth ≥ 10 MHz | 1740A |
| 7. | Frequency Doubler | Operates at 10 MHz | 10515A |
| 8. | Mixer Amplifier** | 10 MHz Mixer/50 dB gain | K79-59992A** |
| 9. | Spectrum Analyzer | 10 MHz/70 dB range | 8552B/8553B |
| 10. | Power Supply | 480 mA @ 20V (2 required) | 6215A |
| 11. | DC Voltmeter | Any HP type digital or analog | |
| 12. | Torque Screwdriver | 2-30 inch-lb. (0.2 to 3.4 newton meters) | 8730-0012 |
| 13. | Feedthru Termination | 50 ohms | 11046B |
| 14. | BNC to Miniature Coax Adapter | Use for 10811B Only | 05060-6116 |
| 15. | Test Connector | For testing 1 0811A | See para. 8-61 |

*Not needed if items 2, 3, 4 are available.
**Not needed if HP 5390A Frequency Stability Analyzer is available.
***If a 105A/B is used, its performance must be verified.

# SECTION II

# INSTALLATION

## *2-1. INTRODUCTION*

2-2. This section contains installation instructions for the 10811A/B Quartz Crystal Oscillator. Also included is information about initial inspection and damage claims, preparation for using the oscillator, and packaging, storage and shipment.

## *2-3. INITIAL INSPECTION*

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the oscillator has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1; procedures for checking electrical performance are given in Section IV. If the contents are incomplete or if there is mechanical damage or defect, or if the oscillator does not pass the Performance Tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement at HP option without waiting for the claim settlement.

## *2-5. PREPARATION FOR USE*

### 2-6. Power Requirements

2-7. The 10811A/B requires two power sources. One supplies power to the oscillator circuitry and the other supplies power to the oven heaters. Table 2-1 lists the required supply voltages and the effect of a change in these voltages on the output frequency.

**Table 2-1. Input Voltages/Voltage Coefficients**

| Input Circuit | Required Voltage | Required Current/Power | Voltage Coefficients | |
|---|---|---|---|---|
| | | | Voltage Change | Frequency Change |
| Oscillator/ Amplifier | 11.0-13.5V dc Noise <100 µV | 30 mA typical, 40 mA max. | 1% | $<2 \times 10^{-10}$ |
| Oven Controller | 20-30V dc | Turn on load is 43 ohms minimum Power drops to steady state value (≈2W) within 10 min. at 25°C with 20V dc applied. | 10% | $<1 \times 10^{-10}$ |

2-8. Both the 10811A and 10811B have separate ground return paths for each section (oscillator and oven circuits). Both grounds may be tied together or operated at any reasonable difference in potential. Note the oscillator supply ground and 10 MHz output have a common ground return. The outer housing for both oscillators is tied to this ground point. The 10811B filtered feedthrough grounds are also tied to the outer housing.

2-9. In order to maintain the high spectral purity of the 10811A/B output signal, the supply voltages must be relatively clean. The supply ripple and noise on the 12-volt line (oscillator supply) must be kept below 100 µV rms and the 20-volt line (oven supply) ripple and noise must be kept below 30 mV rms with both measured in the 10 Hz to 25 kHz range. A 1% change of the 12-volt supply (oscillator) will cause $\leq 2 \times 10^{-10}$ change in output frequency. A 10% change in the 20-volt line (oven) will cause a $\leq 1 \times 10^{-10}$ change in output frequency.

## 2-10. Single Source Regulated Power Supply

2-11. A single source of +20 to +30V dc with 10% regulation may be used to power both the oven and oscillator amplifier circuits if a simple IC regulator is used. A suggested circuit is shown in Figure 2-1. The resistor and capacitor connected to terminals 3 and 4 of the IC minimize ripple and noise in the regulated output.

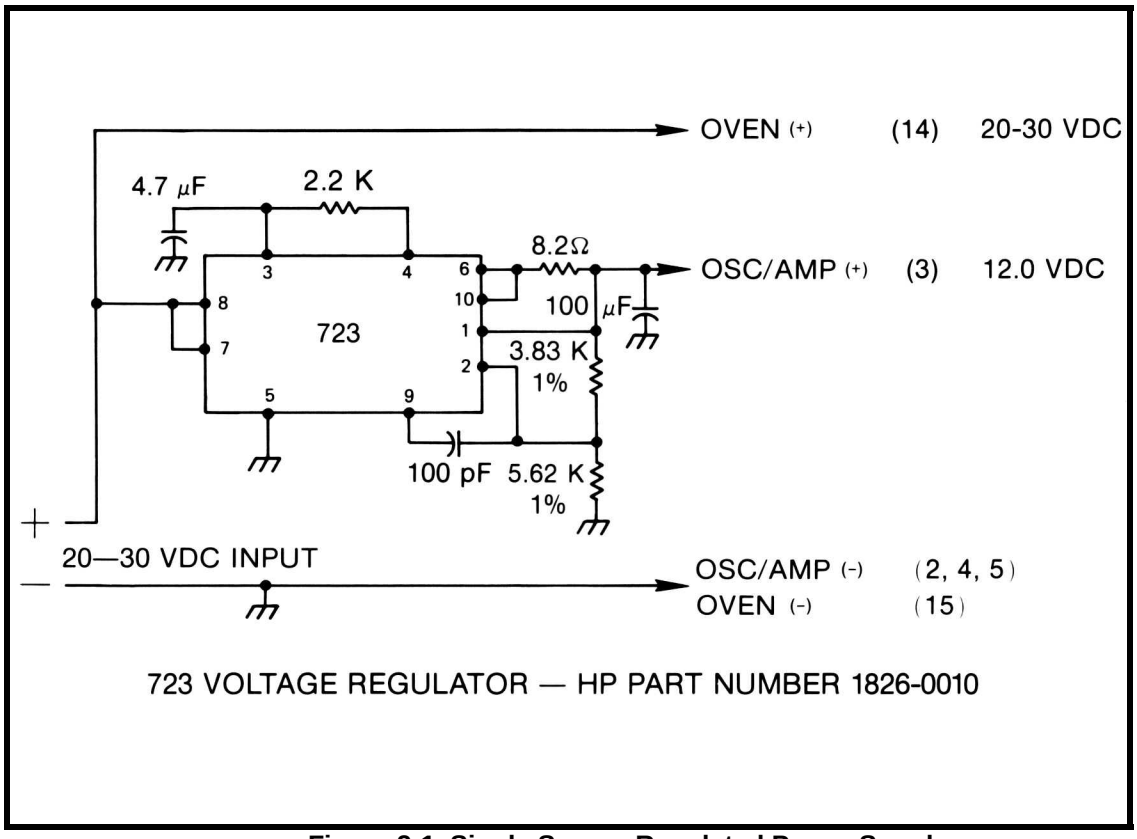



**Figure 2-1. Single Source Regulated Power Supply**

## *2-12. ELECTRONIC FREQUENCY CONTROL (EFC)*

2-13. The EFC allows the oscillator to be tuned over a 1 Hz range (1 x 10-7) by applying -5 to +5 volts to the EFC input. As the EFC voltage goes positive the output frequency will go lower. Conversely, as the EFC voltage goes negative, the output frequency will go higher.

2-14. Since noise on the EFC line affects the oscillator's stability (noise appears as FM on the output), care must be taken to ensure that a relatively noise free EFC voltage source is used. The noise level must be kept below 100 μV to maintain good stability performance.

2-15. The EFC input should be connected to oscillator circuit ground if not used. A shorting plug (1250-0911) is supplied with 10811B for this purpose. The EFC input on the 10811A should be grounded at the printed circuit connector by wiring pins 5 and 6 together.

## 2-16. 10 MHz FREQUENCY OUTPUT SIGNAL

2-17. The 10 MHz output is ac coupled from a source impedance of approximately 50 ohms. The signal level is .55 ±.05 into a 50 ohms load or 1-volt ±20% into a 1 K ohm load.

## 2-18. OVEN MONITOR OUTPUT

2-19. The OVEN MONITOR OUTPUT is an indicator of oven warm-up. At initial turn-on (warmup) the oven monitor will go to approximately 1.5 volts BELOW the oven power supply voltage. After the oven cuts back, the output will drop to approximately 3.5 volts (at 25°C). The output impedance of this circuit is 10,000 ohms. Figure 2-2 shows an oven monitor LED indicator circuit.

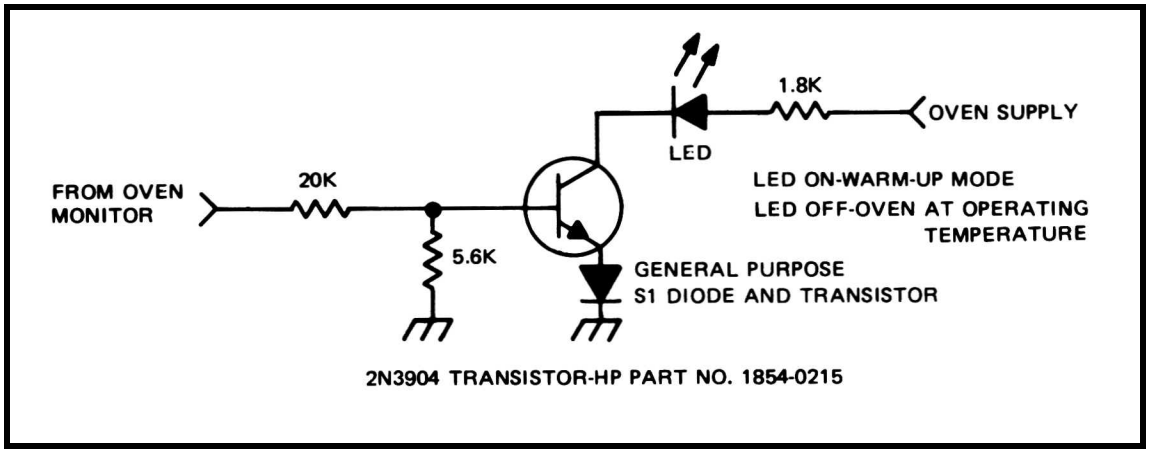
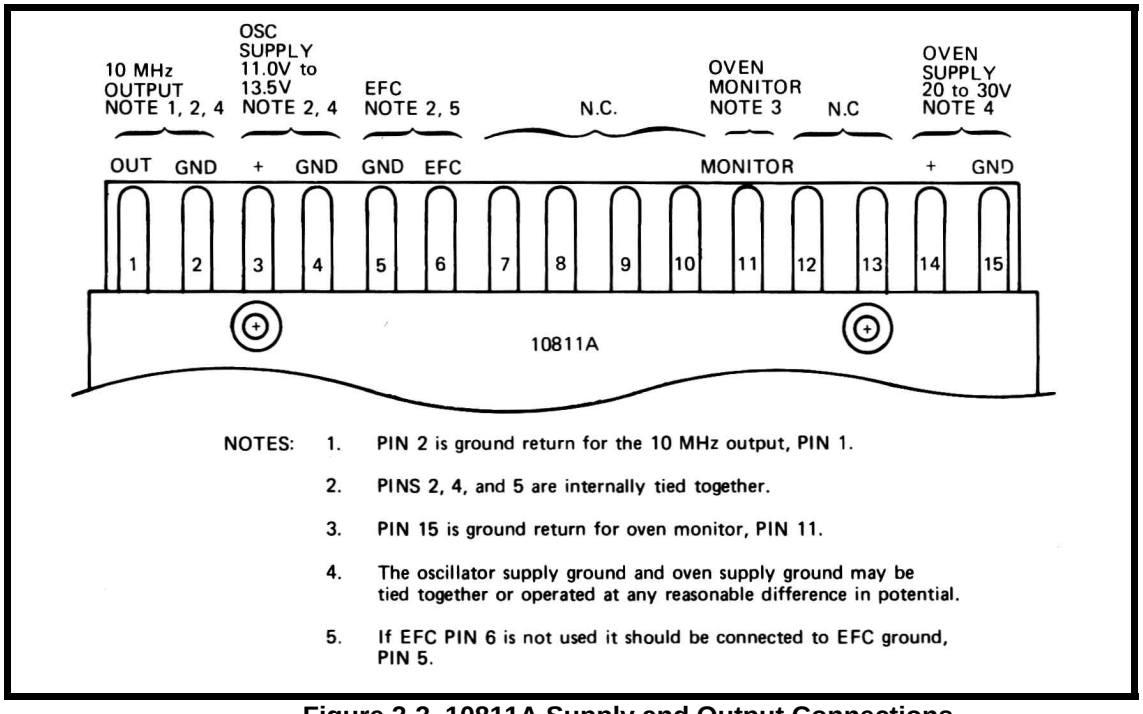



Figure 2-2. Oven Monitor LED Circuit

## 2-20. MATING CONNECTORS AND MOUNTING

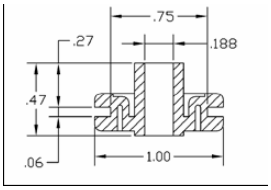
2-21. The 10811A Oscillator requires a 0.156" C-C 15-pin printed circuit connector. The recommended connector is the CINCH ~~250-15-30-210~~ 50-30S-30 (HP 1251-0160), Vishay/Dale (HP 1251-2035) EB81-BN15TGW, EDAC 305-030-500-202 (Mouser 587-307-030) or 305-030-520-202. The 10811A can be secured with two 6-32 screws, 1/4-inch long. Figure 2-3 shows the power supply connection for the 10811A. Figure 2-5 shows the mechanical mounting dimension for the 10811A and 10811B.




NOTES:
1. PIN 2 is ground return for the 10 MHz output, PIN 1.
2. PINS 2, 4, and 5 are internally tied together.
3. PIN 15 is ground return for oven monitor, PIN 11.
4. The oscillator supply ground and oven supply ground may be tied together or operated at any reasonable difference in potential.
5. If EFC PIN 6 is not used it should be connected to EFC ground, PIN 5.

**Figure 2-3. 10811A Supply and Output Connections**

2-22. The 10811B Oscillator uses solder terminals with filtered feedthrough capacitors for power and oven monitor outputs and SMB subminiature rf snap-on connectors for the 10 MHz output and EFC. The 10811B also has one internally threaded mounting stud on the bottom cover and two located on the top. The three studs are threaded for 4-40 screws, 1/4-inch deep. These mounting studs may be used with vibration isolators such as the LORD #J2924-2-1 (HP Part No. 1520-0094). However, for ease of testing and interfacing, a 6-pin Amphenol connector is attached. If you wish to use this connector, the following parts are required to build its mate.




| | |
|---|---|
| Part Number | LORD J292421 |
| Axial Load | 1 (lbs) 4 (N) |
| Deflection | 0.006 (in) 1.5 (mm) |
| Axial Spring Rate | 17 (lbs/in) 2.6 (N/mm) |
| Radial Spring Rate | 17 (lbs/in) 2.6 (N/mm) |
| Thickness | 0.0625 (in) 1.6 (mm) |
| Diameter | 0.735 (in) 18.7 (mm) |

| Description | Quantity | HP Part No. | Amphenol Part No. |
|---|---|---|---|
| Receptacle | 1 | 1251-4297 | 221-1508 |
| Pin-Female | 5 | 1251-4734 | 220-883-03 |
| Guide-Pin | 2 | 1251-0597 | 221-590 |

2-23. If you do not wish to use the Amphenol connector, it may be easily removed. The SMB connectors mate to Cablewave Systems, Inc. #700156 or equivalent HP Part No. 1250-0885 (not supplied). *Figure 2-4* shows the connections for the 10811B Oscillator.

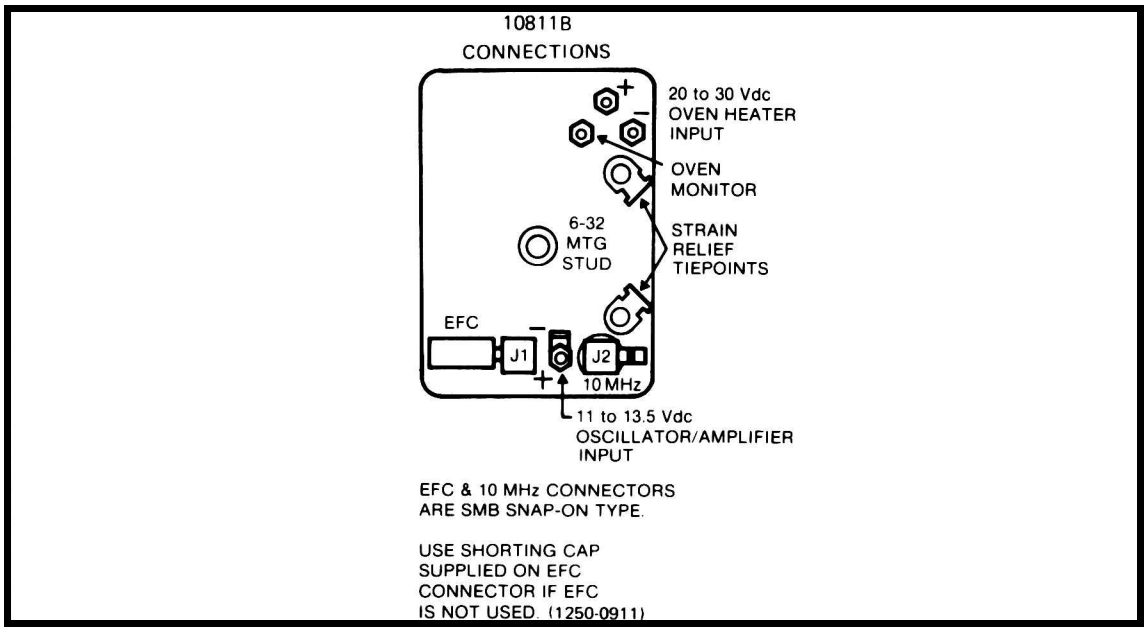



**Figure 2-4. 10811B Supply and Output Connections**

## 2-23. INSTALLATION INSTRUCTIONS

*2-24.* *Figure 2-5* shows the mechanical mounting dimensions of the 10811A/B Oscillators for use in custom installation. Since all quartz oscillators are sensitive to shock, vibration, radiation fields, and ambient temperature changes, to obtain the best performance from your 10811A/B, these factors should be taken into consideration. To optimize performance therefore:

1. The 10811A/B should be mounted in an area that has a minimum amount of vibration or shock accelerations. In addition, the 10811A/B should be mounted so that the vibrational forces act along the "minimum G sensitivity" axis shown in *Figure 2-5*.
2. The 10811A/B should be mounted as far as possible from transformers or fan motors that radiate electromagnetic fields.
3. The 10811A/B should be mounted away from the main system airflow in order to isolate it as much as possible from ambient temperature changes.

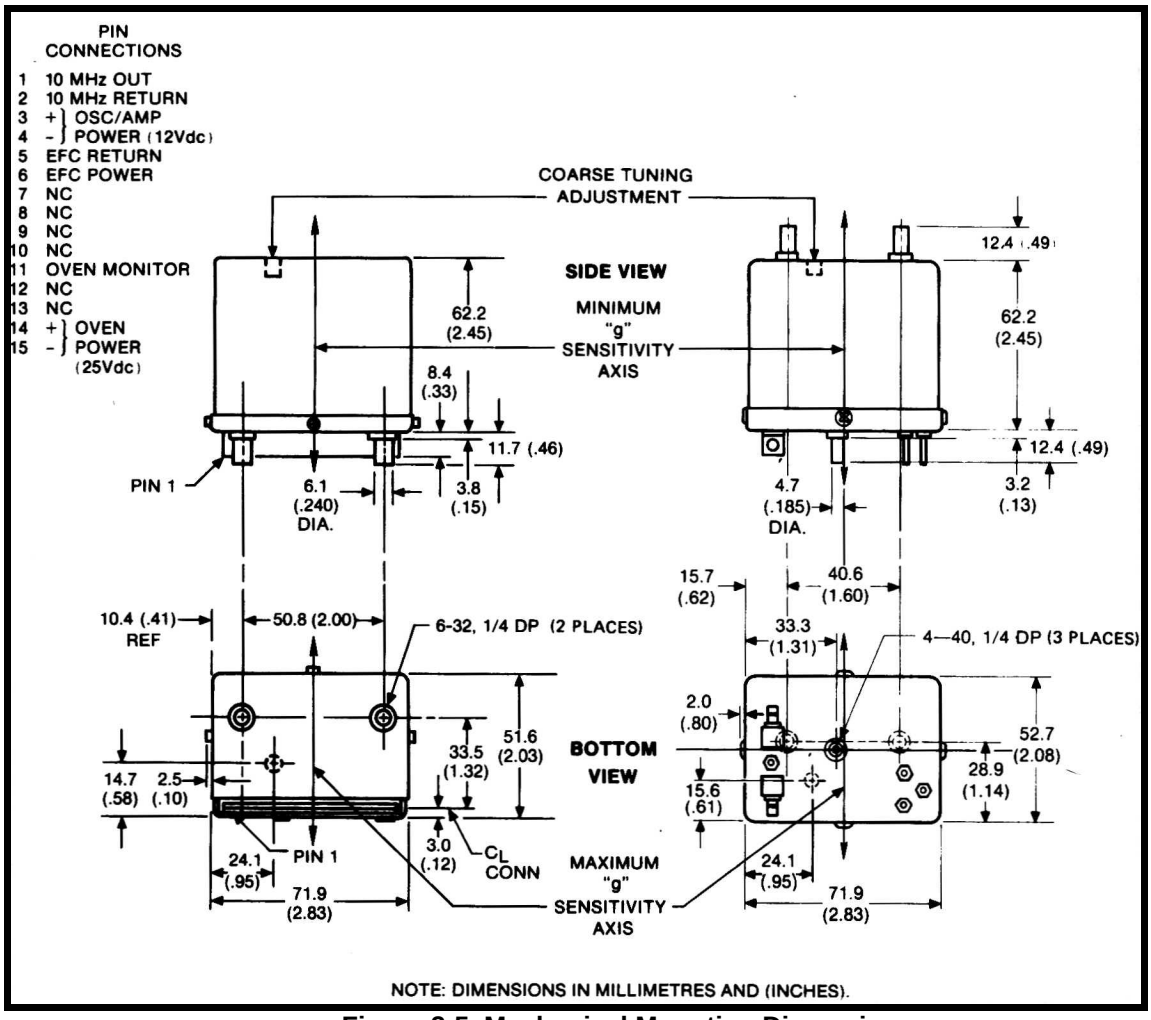



**Figure 2-5. Mechanical Mounting Dimensions**

## *2-25. INSTALLATION INSTRUCTIONS (HP INSTRUMENT)*

2-26. The 10811A may be installed in most Hewlett-Packard instruments that already have a 10544A or 10544B oscillator or has provisions for it. The 10811A may be exchanged directly without any circuit change or modification.

2-27. If the instrument does not have a 10544A oscillator installed, but is available as an option, then the service manual for that instrument should be consulted to see if an oscillator support board (power supplies) is required. Once the support board is installed, the 10811A can be installed in place of the 10544A. Consult your nearest sales and service office for more details.

## *2-28. OPERATING ENVIRONMENT*

2-29. TEMPERATURE. The 10811A/B may be operated in temperatures from -55°C to +71°C.

2-30. MAGNETIC FIELDS. Sidebands due to 0.1 milliTelsa (1 Gauss) rms at 100 Hz will be down more than 90 dB from carrier.

2-32. ALTITUDE. The frequency change will be typically $2 \times 10^{-9}$ for altitudes up to 15.2 km (50,000 ft.).

2-33. SHOCK. The 10811A/B can withstand a shock up to 30 Gs for 11 ms, 1/2 sine wave.

# *2-34. STORAGE AND SHIPMENT*

## 2-35. Environment

2-36. The 10811A/B may be stored or shipped in environments with the following limits:

| | |
|---|---|
| Temperature | -55°C to +85°C |
| Altitude | 15.2 Km (50,000 feet) |

# *2-37. PACKAGING*

## 2-38. Original Packaging

2-39. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required; return address, model number, and full serial number. Also, mark the container Fragile to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

## 2-40. Other Packaging

2-41. The following general instructions should be used for repacking with commercially available materials.

1. Wrap instrument in heavy paper or plastic. (If shipping to ~~Hewlett-Packard office or~~ service center, attach tag indicating type of service required; return address, model number, and full serial number.)
2. Use strong shipping container. A double-wall carton made of 350-pound test material is adequate.
3. Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside container. Protect control panel with cardboard.
4. Seal shipping container securely.
5. Mark shipping container FRAGILE to insure careful handling.
6. In any correspondence, refer to instrument by model number and full serial number.

# SECTION III

# OPERATION

## 3-1. INTRODUCTION

3-2. This section contains operating information including operating characteristics and operating procedure.

## 3-3. BASIC POWER-UP DESCRIPTION

3-4. The following paragraph is a basic description of the actions occurring when power is applied to the oscillator. This description assumes the oscillator is at room temperature (25°C).

3-5. When power is applied to the oscillator, 10 MHz will appear at the output. The oven controller circuit will go into its full warm-up mode. In this mode the maximum heating power is applied to the oven mass. The oven mass is a metal casting surrounding the oscillator circuits and crystal. The OVEN MONITOR output will be approximately 1.5 volts below the oven power supply voltage. In about 10 minutes, the oven will have heated to the proper temperature. The oven controller will begin to regulate at this temperature, and the OVEN MONITOR will drop to approximately 3.5 volts. It is normal for the oven current to drop momentarily to a low value when the oven temperature first reaches maximum. This lasts less than second and is a typical circuit action.

3-6. After the first 10 minutes have passed, the oscillator may be initially adjusted using the following procedure. The oscillator should be readjusted after 24 hours for maximum accuracy. Periodic adjustment schedule can be determined by the procedure described in paragraph 3-10.

## 3-7. FREQUENCY ADJUSTMENT

3-8. The frequency adjustment is the only periodic adjustment required. This may be initially adjusted after 10 minutes of warm-up and then readjusted after 24 hours.

## 3-9. FREQUENCY ADJUSTMENT PROCEDURE

a. Connect reference frequency standard (multiple or submultiple of 10 MHz) to the EXTERNAL SYNC INPUT of the oscilloscope.

b. Connect oscillator output (10811A/B) to Channel A. Set the sweep speed to .1 µs/div.

c. Set the oscilloscope to EXTERNAL TRIGGER and adjust the oscilloscope so that its sweep is synchronized to the reference frequency. The pattern will appear to move.

d. Using an *insulated* tuning tool, adjust oscillator frequency adjustment (FREQ ADJUST on the 10811A/B) for minimum sideways movement of the oscilloscope pattern.

*e.* By timing the sideways movement (divisions per second on the oscilloscope), the approximate offset can be determined based on the oscilloscope sweep speed shown in *Figure 3-1*

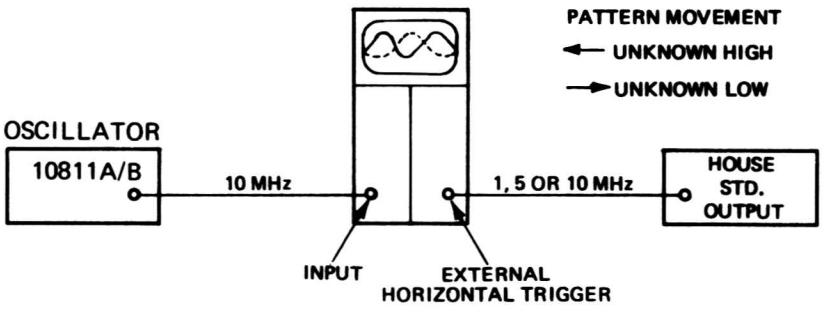
f. For example, if the trace moves 1 division in 10 seconds and the sweep speed is 0.01 µs/div., the oscillator's frequency is 1 x $10^{-9}$ different from that of the reference frequency, as can be seen from the calibration, *Table* 3-1. The calculation can also be made by the following formula:

$$\frac{\Delta \text{ FREQUENCY}}{\text{FREQUENCY}} = \frac{\Delta \text{ TIME}}{\text{TIME}}$$

$$\text{OR} \qquad \frac{\Delta f}{f} = \frac{\Delta t}{t}$$

where Δf/f = offset of the oscillator with respect to the reference standard Δt = the movement of the oscilloscope pattern (1 div. X .01 µs/div.) = .01, µs t = time required for Δt to occur.

$$\frac{\Delta f}{f} = \frac{1 \text{ div} \times 0.01 \ \mu\text{s/div.}}{10 \text{ s}} = 1 \times 10^{-9}$$




| MOVEMENT | SWEEP SPEED | | | NOTES |
|---|---|---|---|---|
| | 1 µs/cm | 0.1 µs/cm | 0.01 µs/cm | |
| 1 cm/s | 1 × 10⁻⁶ | 1 × 10⁻⁷ | 1 × 10⁻⁸ | Time scope trace movement with second hand of watch or clock. |
| 1 cm/10s | 1 × 10⁻⁷ | 1 × 10⁻⁸ | 1 × 10⁻⁹ | |
| 1 cm/100 s | 1 × 10⁻⁸ | 1 × 10⁻⁹ | 1 × 10⁻¹⁰ | |

Sweep movement versus calibration accuracy.

**Figure 3-1. Oscillator Adjustment Set-Up**

## *3-10. ACCURACY VS ADJUSTMENT INTERVAL*

3-11. Table 3-1 shows the required adjustment interval to maintain a required accuracy. If the aging rate is known to be 3 x $10^{-10}$/day, then a more precise adjustment interval can be determined. (The specification for aging is <5 X$10^{-10}$/day, but aging is typically less than this.) The aging rate can be expected to gradually decrease, and typically will reach 1 X $10^{-10}$/day within 1-year.

Example:

Known aging rate·····3 X $10^{-10}$/day
Maximum allowable error ·····5 X $10^{-9}$

3-12. Find the line on Table 3-1 corresponding to the oscillator's aging rate. Then find the maximum allowable error (accuracy) on the horizontal axis. Follow the maximum allowable error vertically until it crosses the oscillator's known aging rate. Move horizontally to the left and read the minimum calibration interval in days.

$$\frac{\text{maximum allowable error}}{\text{known aging rate (per day)}} = \text{calibration interval in days}$$

Example:

$$\frac{5 \times 10^{-9} \text{ (maximum allowable error)}}{3 \times 10^{-10}\text{/day (known aging rate)}} = 16.67 \text{ days (~17 days)}$$ 3 X $10^{-10}$/day (known aging rate)

3-13. From Table 3-1, the oscillator should be adjusted approximately every 17 days.

3-14. The minimum calibration interval may also be determined from the following formula:

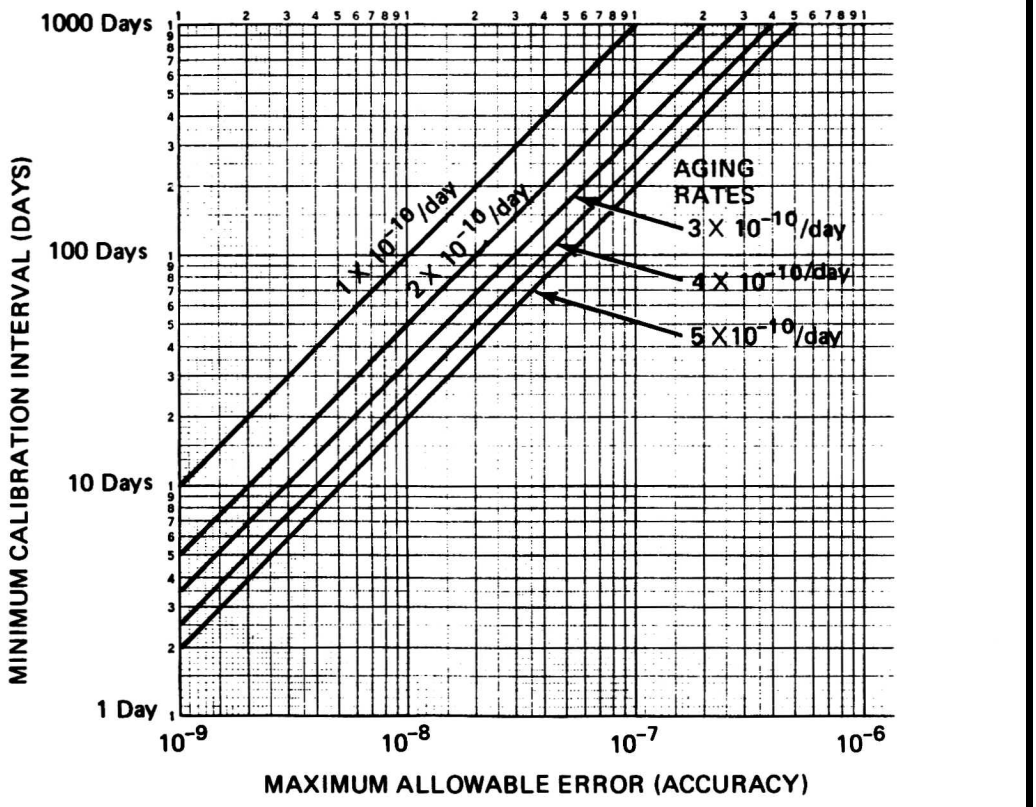



**Table 3-1. Accuracy vs Adjustment**

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# SECTION IV

# OPERATIONAL VERIFICATION

## 4-1. INTRODUCTION

4-2. The tables in this section test the instrument's performance using the specifications of Table 1-1 as the performance standards. All tests can be performed without access to the interior of the instrument.

## 4-3. OPERATIONAL VERIFICATION

4-4. The Operational Verification, Table 4-2, can be performed to give a high degree of confidence that the 10811A/B is operating properly without performing the complete performance tests. The operational verification should be useful for incoming QA, routine maintenance, and after instrument repair.

## 4-5. EQUIPMENT REQUIRED

4-6. Equipment required for the operational verification is listed in the recommended test equipment in Section I, Table 1-2, and in Table 4-1. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

## 4-7. TEST RECORD

4-8. Results of the Operational Verification, *Table* 4-2, may be tabulated on the Operational Verification Record, *Table 4-4*.

4-9. If the 10811A/B Oscillator is to be tested outside its normal installation, a special test connector may be used for applying power to the oscillator. The connector also has a BNC connector for the 10 MHz output signal. A photo, parts list, and construction information is located in Section VIII. The connector should be used under the following circumstances:

a. If the 10 MHz output is not easily accessible.

b. If there is a buffer amplifier between the 10811A/B output and the oscillator output jack on the rear panel of the instrument.

c. Troubleshooting.

d. If testing of the oscillator in its normal installation causes erroneous measurements (e.g., fan noise, vibrations, noisy circuits, etc.). If in doubt, use the special test connector.

*4-10.* *Table* 4-1 lists the five sections of the operational verification and their descriptions.

**Table 4-1. Operational Verification Descriptions**

1. Amplitude (0.55 volts (±0.05 volts/50Ω, 1 volt ± 0.2 volt/1kΩ).
   a. Equipment required:
      BNC-to-BNC Cable
      500 and 1 KΩ loads
      3406A AC Voltmeter
2. Harmonic Distortion (-25 dB below 10 MHz output signal).
   a. Equipment required:
      141T Display Section
      8553B Spectrum Analyzer - RF Section
      8552B Spectrum Analyzer - IF Section
      BNC-to-BNC Cable
3. Spurious Signals - Signals unrelated to the 10 MHz output signal (-100 dB below the 10 MHz output signal).

   NOTE

   Due to the complexity of measuring signal 100 dB below a reference, this procedure will verify that no spurious signals exist greater than 65 dB below the normal 10 MHz output signal.
4.
   a. Equipment required:
      141T Display Section
      8553B Spectrum Analyzer - RF Section 8552B
      Spectrum Analyzer - IF Section
      BNC-to-BNC Cable
5. Short Term Stability (5 X $10^{-12}$ for 1-second averaging; 1 X $10^{-11}$ for 10811-60105).
   a. Equipment required:
      5065A Rubidium Vapor Frequency Standard
      5061A Option 004, or 105A/B, See *Table 1-2*
      HP Model 5390A may be used in place of the following:
         10830A Mixer
         5345A Electronic Frequency Counter with Option 011
         9825A Calculator with 98210A and 98213A or 98214A or 98216A
         98034A HP-IB Interface
      10515A Doubler
      6-Plug AC Power Strip 3
      BNC-to-BNC Cables
6. Long Term Stability -<5 X $10^{-10}$ over 24 hours; 1.5 X $10^{-9}$/24 hours for 10811-60105.
   a. Equipment required:
      HP 1740A 100 MHz Oscilloscope,
      105A/B Quartz Crystal Oscillator,
      5065A Rubidium Frequency Standard, or 5061A Cesium Beam Frequency Standard.
      See *Table 1-2*.

4-11. In the following tests, the power supply voltages to the oscillator are not shown. They are assumed to be:

Oscillator Circuits ..... +12V dc
Oven Circuits ..... +20V dc

4-12. Any supply voltages within the specified limits listed in *Table* 1-1 may be used and will not affect the operational verification. The voltages are only reference points and are used throughout this manual.

**Table 4-2. Operation Verification Procedure**

1. Amplitude Test

Procedure:

a. Set the 3406A Voltmeter to the l-volt range.
b. Insert the 3406A Voltmeter probe into the 1 volt jack on the front panel.
c. With the CAL button out, set the 3406A to zero by adjusting the ZERO control on the front panel.
d. Press the CAL button and adjust the 3406A to read 1V by adjusting the CALIBRATE control on the front panel.
e. Remove the probe from the 1-volt jack and conned to the 10811A/B output through a 50 ohm termination.
f. Verify amplitude of 0.55 volts ±0.05 volts. Mark the test card.
g. Remove the 50Ω termination and replace with a 1 kΩ termination.
h. Verify amplitude of 1 volt ±0.2 volt.

2. Harmonic Distortion

a. Set 141T Spectrum Analyzer controls to:

| | |
|---|---|
| TUNING STABILIZER | OFF |
| BANDWIDTH | 30 kHz |
| SCAN WIDTH per Division | 5 MHz/div. |
| INPUT ATTENUATION | 50 dB |
| VIDEO FILTER | OFF |
| SCAN TIME | 10 ms/div. |
| SCAN MODE | INT |
| SCAN TRIGGER | AUTO |
| LOG REF LEVEL | +10 |
| LOG/LINEAR Switch | 10 dB LOG |

b. Connect the output of the 10811A/B to the spectrum analyzer input.
c. Apply power to the oscillator and spectrum analyzer. Allow 10 minutes for oscillator to stabilize.
d. Adjust Spectrum Analyzer FREQUENCY control so that 10 MHz signal is at left-edge of display (center frequency, approximately 35 MHz).
e. Adjust LOG REF LEVEL vernier control (right hand knob) so that 10 MHz signal is at top of display gratitude. Verify that all harmonics of the 10 MHz signal are more than 25 dB down. Leave spectrum analyzer connected for next test.

3. Spurious Output Signals

a. Use the test setup as described in Test 2.
b. Set the Spectrum Analyzer controls to:

| | |
|---|---|
| TUNING STABILIZER | OFF |
| BANDWIDTH | 1 kHz |
| SCAN WIDTH | .05 MHz |
| INPUT ATTN | 50 dB |
| LOG REFERENCE | +10 dBm |
| SCAN TIME | 0.1 s/div. |
| VIDEO FILTER | 100 Hz |
| SCAN MODE | INT |
| SCAN TRIGGER | AUTO |
| FREQUENCY | 10 MHz (0-11 MHz RANGE) |

c. Adjust FREQUENCY so 10 MHz signal is at center of display. Adjust LOG REF LEVEL so signal is at top of graticule.
d. Set TUNING STABILIZER switch "on" (up) and reset Spectrum Analyzer controls as follows:

| | |
|---|---|
| BANDWIDTH | .03 kHz (30 Hz) |
| SCAN WIDTH | 5 kHz |
| SCAN TIME | 10 s/div. |

Table 4-2. Operational Verification Procedure (Continued)

e. Set INTENSITY and PERSISTENCE controls for an easily readable display at the 10 s scan time.

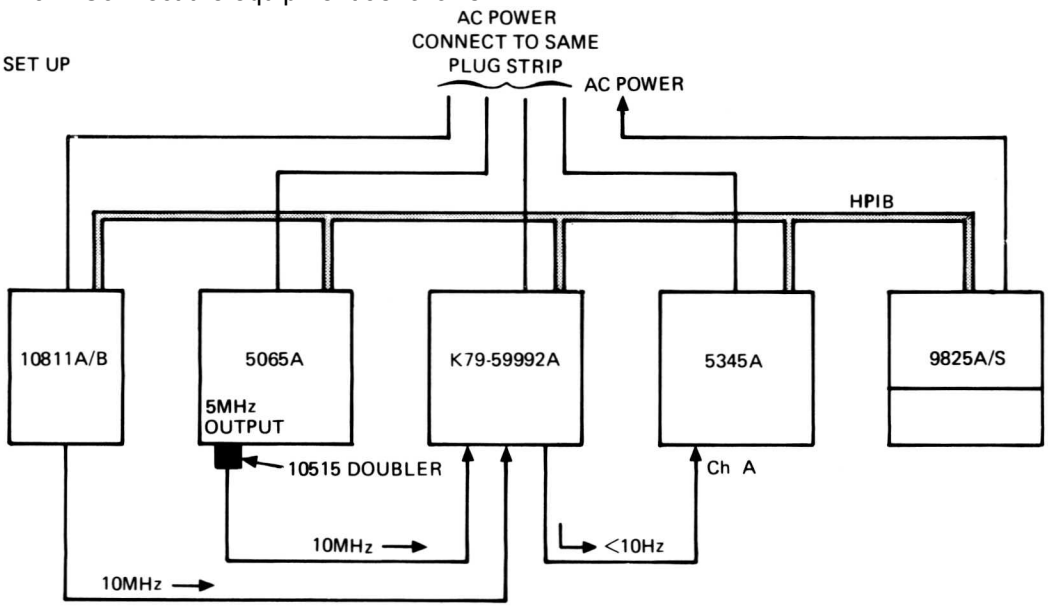
f. Verify that there are no repeating signals above a level 65 dB below the 10 MHz signal (i.e., no signals between -64 dB and 0 dB). Allow the analyzer to sweep through several times to verify that no signals repeat on successive sweeps. Signals greater than -65 dB indicate possible spurious signals on 10811A/B output. Be sure there is no other equipment nearby that could be radiating signals into the measurement. Be sure power supplies meet noise specifications as described in Table 1-1.

4. Short-Term Stability

**NOTE**

If the model 5390A frequency stability analyzer is available it should be used in place of the text described below. Follow instructions in the 5390A operating manual to make measurement.

a. Connect the equipment as follows:




**NOTE**

Arrange the instruments as shown. Keep all signal leads away from power cords and HP-IB cable. DO NOT FORGET THE 10515A DOUBLER ON THE 5065A OUTPUT. Connect all ac power to the same strip so that all ground paths are as short as possible. DO NOT STACK THE INSTRUMENTS. Use coax for all signal leads.

b. Set the 5345A address to 18:

| A5 | A4 | A3 | A2 | |
|---|---|---|---|---|
| 1 (16) | 0 (8) | 0 (4) | 1 (2) | = 18 |

c. Allow 1-hour warmup to stabilize the test equipment and the 10811A/B.

d. Set the 5345A front panel controls as follows:

| | |
|---|---|
| FUNCTION | FREQ A |
| GATE TIME | 1 s |
| SAMPLE RATE | max (ccw) |
| GATE CONTROL INPUT (REAR PANEL) | INTERNAL |
| A LEVEL | PRESET |
| B LEVEL | PRESET |
| A IMPEDANCE | 50 ohm |
| B IMPEDANCE | 50 ohm |
| A ATTENUATOR | X1 |
| B A TTENUATOR | X1 |

Table 4-2. Operational Verification Procedure (Continued)

A COUPLING ..... DC
B COUPLING ..... DC
A SLOPE ..... +
B SLOPE ..... +
CHECK/COM/SEP ..... SEP

e. Adjust the 10811A/B to read ≈9.5 Hz (reading must be less than 10 Hz).

**NOTE**

The display on the 5345A should be changing only in the .001 Hz or .0001 Hz digits. This represents frequency deviations of parts in $10^{11}$ and $10^{12}$, respectively.

f. Type the program from Figure 4-1 into the 9835A calculator. (See paragraph 4-13 for use of other controllers and counters.)
g. Press "RUN". When the program asks for the number of samples, enter "100" and press CONTINUE.
h. Allow 2 to 3 minutes for the program to finish. Verify a short-term stability of less than 5 X $10^{-12}$.

NOTE

Measurement of short-term stability is somewhat difficult and exacting. If the 10811A/B fails this test, be sure no signal sources other than the test reference are operating near the measurement system, as these can cause interference with the measurement. Other sources of error are vi brat ion, nearby electrical equipment, poor shielding, or motors that can radiate signals into the 10811A/B. The failure to connect the HC input (to ground) can cause poor frequency stability as can a noisy voltage being used for the EFC control. If another oscillator is available (known to be good), verify the accuracy of the measurement system. This could save considerable troubleshooting time.

Two other possibilities external to the oscillator are the oven and oscillator power supplies. These must be stable in order for the circuits to function properly. See Table 1-1, Specifications, and paragraph 2-6 for power supply noise requirements.

5. Long-Term Stability

**NOTE**

The 10811A/B will typically take 24 to 48 hours to reach its specified aging rate after storage or shipment. In some cases, if extreme environmental conditions were encountered during storage, the 10811A/B could take up to 1-week to achieve its specified aging rate.

a. Connect reference frequency standard (multiple or submultiple of 10 MHz) to the EXTERNAL SYNC INPUT of the oscilloscope.
b. Connect the output of the 10811A/B to CHANNEL A INPUT. Adjust sweep speed to 0.1 µs/div.
c. Set oscilloscope to EXTERNAL TRIGGER and adjust it so that its sweep is synchronized with the reference frequency. The oscilloscope pattern will probably be moving.
d. Carefully adjust oscillator frequency control so that pattern on oscilloscope stops. Use a higher sweep speed on oscilloscope for better resolution.
e. When the oscillator is adjusted as close as possible to frequency, measure the frequency as described in paragraph 5-13.
f. Allow the oscillator to remain undisturbed for 48 hours, then again measure the frequency. The difference between the frequency measured in step e and that measured in this step is the aging rate per 48 hours and should be less than 1 X $10^{-9}$. The measurement is allowed to run for 48 hours so that the frequency offset measured will be well in excess of the system resolution. In many cases the daily aging rate of <5 X $10^{-10}$ per day can be verified in 24 hours.

**Figure 4-1. BASIC Program**

```
10    ! Short term stability test 10811A/B
20    INPUT “Enter number of samples”,Samples
30    Loop = 0
40    OUTPUT 7,18;“I2E1<:8I2” !5325A Codes
50    ENTER 7,18;A      !Empty dummy buffer
60    ENTER 7,18;A      !First measurement
70    Count = 0
80    FOR Loop = 1 to Samples
90    ENTER 7,18; B     !Successive measurements
100   Count = Count + (A-B)^2
110   A=B
120   FIXED 0
130   DISP Loop
140   NEXT Loop
150   PRINTER IS 0
160   FLOAT 1
170   PRINT “STS=”;SQR(Count/(2*Loop))/1E7
180   GOTO 50
190   STOP
```

## *4-13. OPTIONAL CONTROLLERS AND COUNTERS*

## 4-14. Optional Controllers

4-15. Figure 4-2 lists the program for the 9825A Calculator.

```
0:
1:    “Short term stability test 10811A/B”
2:    “100 Samples is standard value” : ent “Enter number of samples”,S
3:    0→L
4:    “5345A Codes” : wrt 718,”I2E1<:8I2”
5:    “Empty dummy buffer” : red 718,A
6:    “First measurement” : red 718,A
7:    0→C
8:    for L=1 to S
9:    “Successive measurements” : red 718,B
10:   C+(A-B)^2→C
11:   B→A
12:   fxd 0
13:   dsp L
14:   next L
15:
16:   flt 1
17:   “Short term stability formual”: prt “STS=”,SQR(C/(2*L))/1e7
18:   gto 5
19:   stp
```

**Figure 4-2. HPL Program**

## 4-16. Optional Counters

4-17. Table 4-3 shows the program codes set required when using the 5316A counter. Replace line 4 (HPL) or line 40 (BASIC) with the appropriate codes. Be sure the optional counter address is set to "18".

5316A
(gate time must be set manually to 1 s on the front panel)

**Table 4-3. 5316A Program Codes**

1NTR1AT0GA0WA1RE

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**Table 4-4. Operational Verification Record**

*10811A* ☐ *10811B* ☐ *Date* _____

Serial Number _____

| TEST | VALUE | PASS | FAIL |
|---|---|---|---|
| 1. Output Amplitude | _____ | _____ | _____ |
| 2. Harmonic Distortion | _____ | _____ | _____ |
| 3. Spurious Signals | _____ | _____ | _____ |
| 4. Short-Term Stability @$\tau$=1-second | _____ | _____ | _____ |
| 5. Long-Term Stability | _____ | _____ | _____ |

Name _____

# SECTION V

# ADJUSTMENTS

## 5-1. INTRODUCTION

5-2. This section describes the adjustments required to maintain the *10811A/B* operating characteristics within specifications. Adjustments should be made when required, such as after a performance test failure or when components are replaced that may affect an adjustment.

## 5-3. EQUIPMENT REQUIRED

5-4. The test equipment required for the adjustment procedure is listed in *Table 1-2*, Recommended Test Equipment. Substitute instruments may be used if they meet the critical specifications.

## 5-5. FACTORY SELECTED COMPONENTS

5-6. Some of the values in the parts lists are selected during manufacturing to meet circuit requirements. These parts are marked with an asterisk (*) in the parts list and schematic diagrams, with average value shown.

## 5-7. ADJUSTMENT LOCATION

5-8. Adjustment locations are identified in this section and in the component locators in Section VIII, Schematic Diagrams.

## 5-9. SAFETY CONSIDERATIONS

5-10. This section contains warnings and cautions that must be followed for your protection and to avoid damage to the equipment.

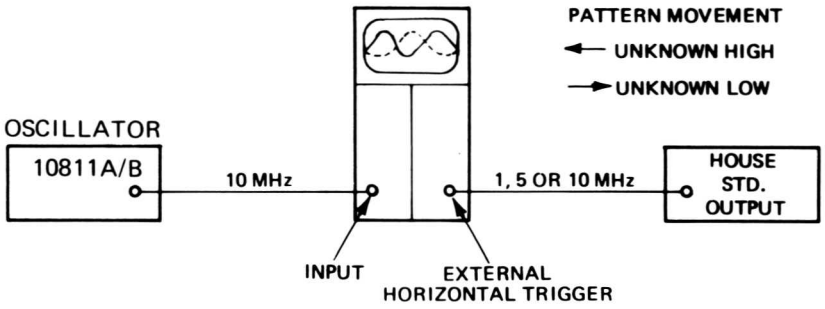
**WARNING**

MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT, AND PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED (FOR EXAMPLE, FIRE AND ELECTRICAL SHOCK). WHERE MAINTENANCE CAN BE PERFORMED WITHOUT POWER APPLIED, THE POWER SHOULD BE REMOVED.
BEFORE ANY REPAIR IS COMPLETED, ENSURE THAT ALL SAFETY FEATURES ARE INTACT AND FUNCTIONING, AND THAT ALL NECESSARY PARTS ARE CONNECTED TO THEIR PROTECTIVE GROUNDING MEANS.

## 5-11. OSCILLATOR FREQUENCY ADJUSTMENT

5-12. The following frequency adjustment procedure is the same for both the 10811A and 10811B. Allow the oscillator to warm up for 24 hours before making this adjustment. See *Figure 5-1*.

a. Connect reference frequency standard (multiple or submultiple of 10 MHz) to the EXTERNAL SYNC INPUT of the oscilloscope. Adjust oscilloscope so that sweep is synchronized with reference frequency.




| MOVEMENT | SWEEP SPEED | | | NOTES |
|---|---|---|---|---|
| | 1 μs/cm | 0.1 μs/cm | 0.01 μs/cm | |
| 1 cm/s | $1 \times 10^{-6}$ | $1 \times 10^{-7}$ | $1 \times 10^{-8}$ | Time scope trace movement with second hand of watch or clock. |
| 1 cm/10s | $1 \times 10^{-7}$ | $1 \times 10^{-8}$ | $1 \times 10^{-9}$ | |
| 1 cm/100 s | $1 \times 10^{-8}$ | $1 \times 10^{-9}$ | $1 \times 10^{-10}$ | |

Sweep movement versus calibration accuracy.

**Figure 5-1. Oscillator Adjustment Setup**

b. Connect oscillator output to Channel A of the oscilloscope. Adjust sweep speed so pattern movement can be seen.

c. Adjust oscillator frequency adjustment (FREQ AD) on 10811A/B Crystal Oscillator unit) for minimum sideways movement of the 10 MHz displayed signal. Increase oscilloscope sweep speed for greater resolution.

## 5-13. Offset Calculation:

a. By timing the sideways movement (divisions per second on the oscilloscope), the approximate offset can be determined based on the oscilloscope sweep speed as shown below.

b. For example, if the trace moves 5 divisions in 10 seconds and the sweep speed is 0.01 μs/div., the oscillators signal is within 5 X 10-9 of the reference frequency. The calculation can also be made as follows:

$$\frac{\Delta f}{f} = \frac{\Delta t}{t}$$

$$\frac{\Delta f}{f} = \frac{5 \times 0.01\ \mu s/div.}{10\ s} = 5 \times 10^{-9}$$

Where:

Δf/f is the normalized frequency difference between the 10811A/B and the reference signal
Δt is the change observed in the oscilloscope
t is the time required for Δt to occur.

## *5-14. OUTPUT AMPLITUDE ADJUSTMENT*

5-15. The output amplitude is adjusted by the setting of the variable resistor R6 which is in the feedback of the AGC circuitry. It is not accessible from the outside of the oscillator.

5-16. The following procedure should be used to adjust the output amplitude only if the output level falls outside the specified level, or repairs have been made to the main oscillator or AGC circuitry.

1. Remove oscillator from instrument.

**WARNING**

THE OSCILLATOR'S INTERNAL OVEN MASS TEMPERATURE MAY BE AS HIGH AS 85°C (185°F). TO AVOID SERIOUS BURNS DO NOT REMOVE OSCILLATOR CIRCUITS AND/OR OVEN MASS ASSEMBLY FROM THE OUTER HOUSING UNTIL THE OSCILLATOR HAS SUFFICIENTLY COOLED (APPROXIMATELY 1 HOUR WITH BOTTOM COVER AND FOAM INSULATOR REMOVED). THE OUTER HOUSING TEMPERATURE IS NOT A RELIABLE INDICATION OF THE INTERNAL TEMPERATURE.

2. Remove bottom cover and allow oscillator to cool (if previously operated). To remove cover:

   a. For the 10811A, remove the three screws securing the bottom cover. Remove the two screws securing the P.c. edge connector to the outer can. Remove the top foam insulator to expose the oscillator circuits.

**CAUTION**

**DO NOT pull the oscillator out of the outer housing by pulling on the P.C. edge connector or flex circuit!!**

   b. For the 10811B remove the four screws securing the bottom cover. Disconnect the bottom cover flex circuit from the seven pin connector.

3. Once the oscillator is cool enough to handle, remove the oscillator assembly by pushing on the tuning capacitor (top of oscillator) with a long, small diameter tool until the oscillator assembly can be removed freely.

**NOTE**

**Under no circumstances should the oven circuit be operated with the oven mass removed from the outer housing. To do so will cause damage to components inside the oven mass.**

4. Obtain HP Model 6215A Power Supply or equivalent. Preset power supply to 12V dc. Turn off power supply before proceeding to next step.

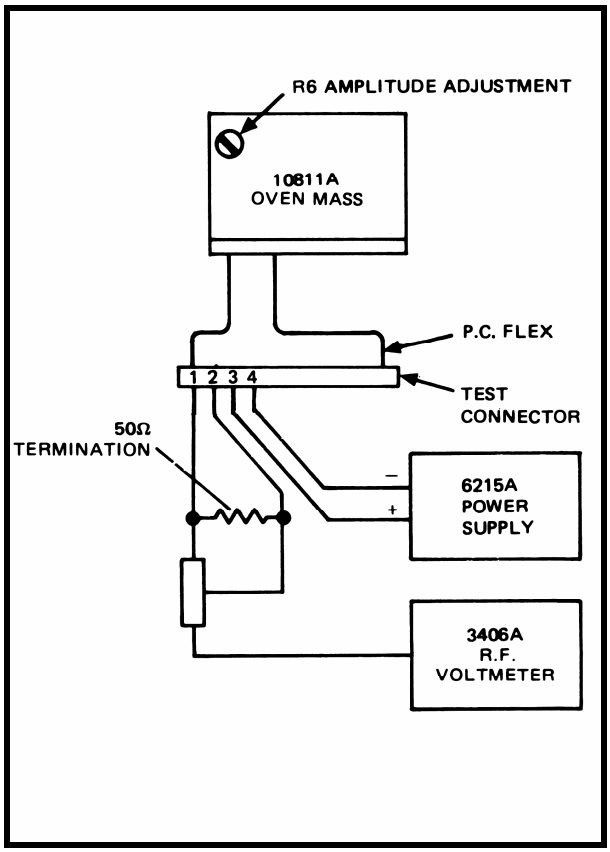



**Figure 5-2. 10811A Amplitude Adjustment Set-up**

5. For the 10811A, connect Model 6215A Power Supply to pins 2 Hand 3 (+) of a 15 pin printed circuit connector.

   a. Insert the 10811A P.c. edge connector into the 15 pin P.c. connector. (See Section VIII for a special 10811A test connector.)

   b. Connect pin 1 of the 15 pin pc connector through a 50Ω termination (use pin 2 as ground) to a 3406A Sampling Voltmeter. See Figure 5-2. Do not apply power to the oven circuits.

   c. For the 10811B, reconnect the flex circuit attached to the bottom cover and connect the 6215A as shown in Figure 5-3. DO NOT APPLY POWER TO THE OVEN CIRCUITS. A Micon to BNC adaptor is available for the 10 MHz output (HP Part Number 05060-6116).

   d. For both 10811A and B, turn on the 6215A power supply and adjust R6 AGC control for .55V rms ±50 mV as read on the 3406A Sampling Voltmeter. R6 is accessible through the small hole in the side of the oven mass.

6. Turn off the 6215A power supply and reassemble the oscillator.

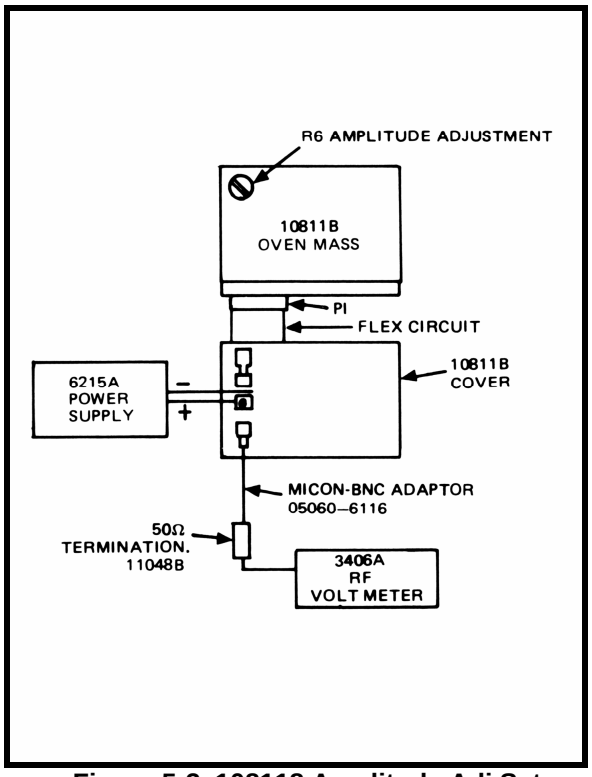



**Figure 5-3. 108118 Amplitude Adj Set-up**

# SECTION VI

# REPLACEABLE PARTS

## 6-1. INTRODUCTION

6-2. This section contains information for ordering replacement parts. *Table* 6-1 lists parts in alphanumerical order of their reference designators and indicates the description and HP Part Number of each part, together with any applicable notes. The table includes the following information.

a. Description of part (see abbreviations below).
b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in *Table 6-2*.
c. Manufacturer's part number.
d. Total quantity used in the instrument (Qty column).

## 6-3. ORDERING INFORMATION

6-4. To obtain replacement parts, address order of inquiry to your local Hewlett-Packard Sales and Service Office (see lists at rear of this manual for addresses). Identify parts by their Hewlett Packard part numbers.

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.
e. Check digit.
f. Quantity required.

## 6-5. HP PART NUMBER ORGANIZATION

6-6. The following is a general description of the HP part number system.

## 6-7. Component Parts and Materials

6-8. Generally, the prefix of HP part numbers identifies the type of device. Eight-digit part numbers are used, where the four-digit prefix identifies the type of component, part, or material and the four-digit suffix indicates the specific type. Following is a list of some of the more commonly used prefixes for component parts. The list includes HP manufactured parts and purchased parts.

| Prefix | Component Part Material |
|---|---|
| 0121- | Capacitors, Variable (mechanical) |
| 0122- | Capacitors, Voltage Variable (semiconductor) |
| 0140- | Capacitors, Fixed |
| 0150- | Capacitors, Fixed, |
| 0160- | Capacitors, Fixed |
| 0180- | Capacitors, Fixed Electrolytic |
| 0330- | Insulating Materials |
| 0340- | Insulators, Formed |
| 0370- | Knobs, Control |
| 0380- | Crystals |
| 0470- | Adhesives |
| 0490- | Relays |
| 0510- | Fasteners |
| 0674- through 0778- | Resistors, Fixed (non wire wound) |
| 0811- through 0831- | Resistors (wire wound) |
| 1200- | Sockets for components |
| 1205- | Heat Sinks |
| 1250- | Connectors (RF and related parts) |
| 1251- | Connectors (non RF and related parts) |
| 1410- | Bearings and Bushings |
| 1420- | Batteries |
| 1820- | Monolithic Digital Integrated Circuits |
| 1826- | Monolithic Linear Integrated Circuits |
| 1850- | Transistors, Germanium PNP |
| 1851- | Transistors, Germanium NPN |
| 1853- | Transistors, Silicon PNP |
| 1854- | Transistors, Silicon NPN |
| 1855- | Field-Effect- Transistors |
| 1900- through 1912- | Diodes |
| 1920- through 1952- | Vacuum Tubes |
| 1990- | Semiconductor Photosensitive and Light-emitting Diodes |
| 3100- through 3106- | Switches |
| 8120- | Cables |
| 9100- | Transformers, Coils, Chokes, Inductors, and Filters |

6-9. For example, 1854-0037, 1854-0221 and 1851-0192 are all NPN transistors. The first two are silicon and the last is germanium.

## 6-10. GENERAL USAGE PARTS

6-11. The following list gives the prefixes for HP manufactured parts used in several instruments, e.g., side frames, feet, top and bottom covers, etc. These are eight-digit part numbers with the four-digit prefix identifying the type of parts as shown below:

| Type of Part | P/N Suffix |
|---|---|
| Sheet Metal | 5000- to 5019- |
| Machined | 5020- to 5039- |
| Molded | 5040- to 5059- |
| Assembly | 5060- to 5079 |
| Component | 5080- to 5099 |

## 6-12. Specific Instrument Parts

6-13. These are HP manufactured parts for use in individual instruments or series of instruments. For these parts, the prefix indicates the instrument and the suffix indicates the type of part. For example, 05328-60001 is an assembly used in the 5328A. Following is a list of suffixes commonly used.

| Type of Part | P/N Suffix |
|---|---|
| Sheet Metal | -00000 to -00499 |
| Machined | -20000 to -20499 |
| Molded | -40000 to -40499 |
| Assembly | -60000 to -60499 |
| Component | -80000 to -80299 |
| Documentation | -90000 to -90249 |

## 6-14. Factory Selected Parts

6-15. Some of the values in the parts list are selected during manufacture to meet circuit requirements. These parts are marked with an asterisk (*) in the parts list and schematic diagrams, with average values shown.

6-16. The 10811A/B Oscillator contains only one factory selected part which is R20 OVEN TEMPERATURE SET resistor. This resistor is supplied with the crystal, should the crystal require replacement. Table 8-1 lists the various resistors and their corresponding part numbers.

## 6-20. REPLACEABLE PARTS LIST LAYOUT

6-21. The 10811A and 10811B Oscillators are identical internally, except that the 10811B has had the 15-pin pc edge connector removed and a 7-pin connector (11) placed on the board for the 10811B bottom cover flex circuit (see Figure 8-15). The only other difference is the outer housings. Thus the parts lists for the circuit boards are identical. The parts lists are set up in the following manner:

1. 10811A and 10811B Circuit Board Components and Miscellaneous Parts.
2. 10811A and 10811B Transistor Mounting Hardware.
3. 10811A and 10811B Oven Mass Assembly and covers.
4. 10811A Mechanical Parts (Housing).
5. 10811B Mechanical Parts (Housing).

## Table 6-1. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| | 10811-60001 | 3 | 1 | CIRCUIT BOARD COMPONENTS 10811A/B | 28480 | 10811-60001 |
| C1 | 0121-0511 | 6 | 1 | TUNING CAPACITOR | 28480 | 0121-0511 |
| C2 | 0160-0576 | 5 | 11 | CAPACITOR-FXD .1uF ±20% 50VDC CER | 28480 | 0160-0576 |
| C3 | 0160-5109 | 0 | 1 | CAPACITOR-FXD 15pF ±5% 50VDC CER 0±30 | 28480 | 0160-5109 |
| C4 | 0160-0576 | 5 | | CAPACITOR-FXD .1uF ±20% 50VDC CER | 28480 | 0160-0576 |
| C5 | 0160-0576 | 5 | | CAPACITOR-FXD .1uF ±20% 50VDC CER | 28480 | 0160-0576 |
| C6 | 0160-4935 | 8 | | CAPACITOR-FXD 510pF ±1% 100VDC CER | 72982 | 8121-100-COGO-511F |
| C7 | 0160-0576 | 5 | | CAPACITOR-FXD .1uF ±20% 50VDC CER | 28480 | 0160-0576 |
| C8 | 0160-5110 | 3 | 1 | CAPACITOR-FXD 62pF ±1% 50VDC CER 0±30 | 28480 | 0160-5110 |
| C9 | 0160-0576 | 5 | | CAPACITOR-FXD .1uF ±20% 50VDC CER | 28480 | 0160-0576 |
| C10 | 0160-3874 | 2 | 2 | CAPACITOR-FXD 10pF ±.5PF 200VDC CER | 28480 | 0160-3874 |
| C11 | 0160-0576 | S | | CAPACITOR-FXD .1uF ±20% 50VDC CER | 28480 | 0160.0576 |
| Cl2 | 0160-4512 | 7 | 2 | CAPACITOR-FXD 120pF ±5% 200VDC CER | 51642 | 200-200-NP0-121J |
| C13 | 0160-3479 | 7 | 3 | CAPACITOR-FXD .01uF ±20% 100VDC CER | 28480 | 0160-3879 |
| C14 | 0160-0576 | 5 | | CAPACITOR-FXD .1uF ±20% 50VDC CER | 28480 | 0160-0576 |
| C15 | 0180-2617 | 1 | 1 | CAPACITOR-FXD 6.8uF +.10% 35VDC TA | 25085 | D6R8G81B35K |
| C16 | 0160-0576 | 5 | | CAPACITOR-FXD .1uF ±20% 50VDC CER | 28480 | 0160-0576 |
| C17 | 0160-3874 | 2 | | CAPACITOR-FXD 10pF ±.5pF 200VDC CER | 28480 | 0160-3874 |
| C18 | 0160-4947 | 2 | 1 | | 28480 | 0160-4947 |
| C19 | 0160-3879 | 7 | | CAPACITOR-FXD .01uF ±20% 100VDC CER | 28480 | 0160-3879 |
| C20 | 0160-3879 | 7 | | CAPACITOR-FXD .01uF +.20% 100VDC CER | 28480 | 0160-3879 |
| C21 | 0160-0576 | 5 | | CAPACITOR-FXD .1uF +.20% 50VDC CER | 28480 | 0160-0576 |
| C22 | 0160-0576 | 5 | | CAPACITOR-FXD .1uF +.201 50VDC CER | 28480 | 0160-0576 |
| C23 | 0160-4512 | 7 | | CAPACITOR-FXD 120pF +.5% 200VDC CER | 51642 | 200-200-NP0-121J |
| C24 | 0160-0576 | 5 | | CAPACITOR-FXD .1uF +.20% 50VDC CER | 28480 | 0160-0576 |
| CR1 | 0122-0244 | 4 | 1 | DIODE-VVC 100PF 5% C4/C25-MIN=2 BVR-30V | 28480 | 0122-0244 |
| CR2 | 1901-0869 | 2 | 1 | DIODE-CUR RGLTR 1N5297 DO=7 | 04713 | 1N5297 |
| CR3 | 1902-0984 | 4 | 1 | DIODE-ZNR 6,4V 2% DO=7 PD = .4W TC=+.002% | 28480 | 1902.0984 |
| CR4 | 1901-0535 | 9 | 3 | DIODE-SCHOTTKY | 28480 | 1901.0535 |
| CR5 | 1901-053S | 9 | | DIODE-SCHOTTKY | 28480 | 190100535 |
| CR6 | 1901-0535 | 9 | | DIODE-SCHOTTKY | 28480 | 1901-0535 |
| E1 | 9170-0029 | | 1 | FERRITE BEAD (FOR Q1) | 28480 | 9170-0029 |
| F1 | 2110-0617 | 6 | 1 | FUSE-THERMAL (10811-80008) | 28480 | 2110-0617 |
| L1 | 9100-2280 | 5 | S | INDUCTORRF-CH-MLD 220uH 10% .10SDX.26LG | 28480 | 9100.2280 |
| L2 | 9140-0352 | 2 | 1 | INDUCTORRF-CH-MLD 330nH 1% .10SDX.26LG | 28480 | 9140.0332 |
| L3 | 9140-0353 | 3 | 1 | INDUCTORRF-CH-MLD 430hN 1% .10SDX.26LG | 28480 | 9140.0353 |
| L4 | 9100-2276 | 9 | 1 | INDUCTORRF-CH-MLD 100uH 10% .10SDX.26LG | 28480 | 910002276 |
| LS | 9100-2280 | 5 | | INDUCTORRF-CH-MLD 220uH 10% .10SDX.26LG | 28460 | 9100-2250 |
| L6 | 9100-2280 | 5 | | INDUCTORRF-CH-MLD 220uH 10% .10SDX.26LG | 28480 | 910002280 |
| L7 | 9100-2280 | 5 | | INDUCTORRF-CH-MLD 220uH 10% .10SDX.26LG | 28480 | 9100.2280 |
| L8 | 9100-2280 | 5 | | INDUCTORRF-CH-MLD 220uH 10% .10SDX.26LG | 28480 | 9100.2280 |
| Q1 | 1854-0853 | 3 | 3 | TRANSISTOR, SPL 2N5179 | 28460 | 1854-0853 |
| Q2 | 1954-0853 | 3 | | TRANSISTOR, SPL 2N5179 | 28480 | 1854-0853 |
| Q3 | 1854-0853 | 3 | | TRANSISTOR, SPL 2N5179 | 28480 | 1854-0853 |
| Q4 | 1854-0831 | 7 | 2 | TRANSISTOR NPN 2N6429A T0-92 PD=625mW | 01713 | 2N6429A |
| Q5 | 1854-0831 | 7 | | TRANSISTOR NPN 2N6429A T0-92 PD=625mW | 04713 | 2N6429A |
| Q6 | 1854-0023 | 9 | 1 | TRANSISTOR NPN S1 TO-18 PD=360mW | 28480 | 1854-0023 |
| Q7 | 10811-80001 | 0 | 2 | TRANSISTOR NPN SI DARL TO-22049 PD=70W | 04713 | 10811-80001 |
| Q8 | 10811-80001 | 0 | | TRANSISTOR NPN SI DARL TO-220AB PD=7OW | 04713 | 10811-80001 |
| Q9 | 18S4-0833 | 9 | 1 | TRANSISTOR NPN PD.600Mw FT6600m142 | 28480 | 1554-0833 |
| R1 | 0698-7284 | 5 | 5 | RESISTOR 100K 1% .05W F TC.0+•100 | 24546 | C3-1/8-T0-1003-G |
| R2 | 0698-7284 | 5 | | RESISTOR 100K 1% .50W F IC60+.100 | 24546 | C3-1/8-T0-1001-G |
| R3 | 0699-0073 | 8 | 2 | RESISTOR 10M 1% .125W F IC60+6,100 | 28480 | 0699.0073 |
| R4 | 0699-0073 | 8 | | RESISTOR 10M 1% .125W F TCs0+.100 | 28480 | 0699.0073 |
| R5 | 0698-7263 | 0 | 1 | RESISTOR 13.3K 1% .05W F TCs0+•100 | 24546 | C3-1/8-T0-1332-G |
| R6 | 2100-2489 | 9 | 1 | RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN | 30983 | ETS0X502 |
| R7 | 0698-7272 | 1 | 1 | RESISTOR 31.6K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-3162-G |
| R8 | 0698-7232 | 3 | | RESISTOR 681 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-681R-G |
| R9 | 0698-7256 | 1 | 2 | RESISTOR 6.61K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-6811-G |
| R10 | 0698-7256 | 1 | | RESISTOR 6.61K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-6811-G |
| R11 | 0698-7244 | 7 | 1 | RESISTOR 2.15K 1% ,05W F TC=0±100 | 24546 | C3-1/8-T0-2151-G |
| R12 | 0698-7261 | 8 | 1 | RESISTOR 11K 1% .05w F TC=0±100 | 24546 | C3-1/8-T0-110244 |
| R13 | 0698-7224 | 3 | | RESISTOR 316 1% 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-316R-G |
| R14 | 0698-7280 | 1 | 1 | RESISTOR 68.1K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-6812-G |
| R15 | 0698-7284 | 5 | | RESISTOR 100K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1003-G |
| R16 | 0698-7235 | 6 | | RESISTOR 909 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-909R.G |
| R17 | 0698-7260 | 7 | 2 | RESISTOR 10K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1002-G |
| R18 | 0698-3903 | 7 | 5 | RESISTOR 8.6K .1% .05W F TC=0±10 | 28480 | 0698.3903 |
| R19 | 0696-3903 | 7 | | RESISTOR 11.6K .1% .05W F TC=0±10 | 28480 | 069803903 |
| R20* | 0698-0096 | 3 | 1 | RESISTOR 968 1% .125W F TC=0±100 | 03888 | PME55-1/8-T0-9680-F |
| R20* | 0698-3495 | 2 | 1 | RESISTOR 866 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-866R-F |
| R20* | 0698-3512 | 4 | 1 | RESISTOR 1.18K 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-1181-F |

Table 6-1. Replaceable Parts (Continued)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| R20* | 0698-3700 | 2 | 1 | RESISTOR 715 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-715R-F |
| R20* | 0698-4014 | 3 | 1 | RESISTOR 787 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-787R-F |
| R20* | 0696-4196 | 2 | 1 | RESISTOR 1.07K 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-1071-F |
| R20* | 0696-4460 | 3 | 1 | RESISTOR 649 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-649R-F |
| R20* | 0696-4465 | 6 | 1 | RESISTOR 931 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-931R-F |
| R20* | 0698-4469 | 2 | 1 | RESISTOR 1.15K 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-1151-F |
| R20* | 0698-5652 | 9 | 1 | RESISTOR 500 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-500R-F |
| R20* | 0698-6970 | 4 | 1 | RESISTOR 1.04K .5% .125W F TC=0±50 | 28480 | 0698-6970 |
| R20* | 0698-6973 | 7 | 1 | RESISTOR 1.25K .25% .125W F TC=0±25 | 28480 | 0698-6973 |
| R20* | 0696-6981 | 7 | 1 | RESISTOR 1.29K .5% .125W F TC=0±50 | 28480 | 0698-6981 |
| R20* | 0698-7201 | 6 | 1 | RESISTOR 34.6 1% .05W F TC=0±100 | 24546 | C3-1/8-T00-34R8-G |
| R20* | 0698-7207 | 2 | 1 | RESISTOR 61.9 1% .05W F TC=0±100 | 24546 | C3-1/8-T00-61R9-G |
| R20* | 0698-7212 | 9 | 1 | RESISTOR 100 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-100R-G |
| R20* | 0698-7214 | 1 | 1 | RESISTOR 121 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-121R-G |
| R20* | 0698-7217 | 4 | 1 | RESISTOR 162 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-162R.G |
| R20* | 0698-7219 | 6 | 1 | RESISTOR 196 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-196R-G |
| R20* | 0698-7220 | 9 | 2 | RESISTOR 215 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-215R-G |
| R20* | 0698-7222 | 1 | 1 | RESISTOR 261 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-261R-G |
| R20* | 0698-7223 | 2 | 1 | RESISTOR 287 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-287R-G |
| R20* | 0698-7224 | 3 | 2 | RESISTOR 316 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-316R-G |
| R20* | 0698-7225 | 4 | 1 | RESISTOR 348 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-348R-G |
| R20* | 0696-7226 | 5 | 1 | RESISTOR 383 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-383R-G |
| R20* | 0698-7227 | 6 | 1 | RESISTOR 422 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-422R-G |
| R20* | 0696-7228 | 7 | 1 | RESISTOR 464 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-464R-G |
| R20* | 0698-7229 | 8 | 2 | RESISTOR 511 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-511R-G |
| R20* | 0698-7230 | 1 | 1 | RESISTOR 562 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-562R-G |
| R20* | 0698-7231 | 2 | 1 | RESISTOR 619 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-619R-G |
| R20* | 0698-7232 | 3 | 4 | RESISTOR 681 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-681R-G |
| R20* | 0698-7233 | 4 | 1 | RESISTOR 750 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-750R-G |
| R20* | 0698-7254 | 5 | 1 | RESISTOR 825 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-825R-G |
| R20* | 0698-7235 | 6 | 2 | RESISTOR 909 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-909R-G |
| R20* | 0698-7236 | 7 | 1 | RESISTOR 1K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1001-G |
| R20* | 0698-7237 | 8 | 1 | RESISTOR 1.1k 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1101-G |
| R20* | 0696-7238 | 9 | 1 | RESISTOR 1.21K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1211-G |
| R20* | 0698-7239 | 0 | 1 | RESISTOR 1.33K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1331-G |
| R20* | 0757-1100 | 8 | 1 | RESISTOR 600 1% .125W F TC=0±100 | 24546 | C4-1/8-T0-601-F |
| R21 | 0698-3903 | 7 | | RESISTOR 8.6K .1% .05W F TC=0±10 | 28480 | 0696-3903 |
| R22 | 0698-8827 | 4 | 2 | RESISTOR 1M 1% .125W F TC=0±100 | 28480 | 0696-6627 |
| R23 | 0698-6827 | 4 | | RESISTOR 1M 1% .125W F TC=0±100 | 28480 | 0696-6627 |
| R24 | 0699-0071 | 6 | 1 | RESISTOR 4.64M 1% .125W F TC=0±100 | 28480 | 0699-0071 |
| R25 | 0698-7273 | 2 | 1 | RESISTOR 54.8K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-3482-G |
| R26 | 0698-3903 | 7 | | RESISTOR 6,6K .1% .05W F TC=0±100 | 28480 | 0698-3903 |
| R27 | 0698-3903 | 7 | | RESISTOR 6.6K .1% 05W F TC=0±100 | 28480 | 0698-3903 |
| R28 | 0698-7265 | 2 | 1 | RESISTOR 16.2K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1622-G |
| R29 | 0698-7260 | 7 | | RESISTOR 10K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1002-G |
| R30 | 0698-7267 | 4 | 1 | RESISTOR 19.6K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1962-G |
| R31 | 0698-7220 | 9 | | RESISTOR 215 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-215R-G |
| R32 | 0698-7250 | 5 | 2 | RESISTOR 3.83K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-3831-G |
| R33 | 0698-7284 | 5 | | RESISTOR 100K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1003-G |
| R34 | 0696-7247 | 0 | 1 | RESISTOR 2.87K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-2871-G |
| R35 | 0698-7250 | 5 | | RESISTOR 3.63K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-3831-G |
| R36 | 0696-7264 | 5 | | RESISTOR 100K 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-1003-G |
| R37 | 0698-7232 | 3 | | RESISTOR 681 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-681R-G |
| R38 | 0696-8812 | 7 | 2 | RESISTOR 1 1% .125W F TC=0±100 | 28480 | 0696-6612 |
| R39 | 0696-6812 | 7 | | RESISTOR 1 1% .125W F TC=0±100 | 28480 | 0696-6612 |
| R40 | 0698-7229 | 8 | | RESISTOR 511 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-511R-G |
| R41 | 0698-7215 | 2 | 1 | RESISTOR 133 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-133R-G |
| R42 | 0698-7232 | 3 | | RESISTOR 681 1% .05W F TC=0±100 | 24546 | C3-1/8-T0-681R-G |
| T1 | 9100-0425 | 0 | 1 | TRANSFORMER RF; WIND 9T PRI & 3T SEC | 28480 | 9100-0423 |
| U1 | 1826-0611 | 2 | 1 | IC OP AMP GP DUAL 8-DIP-P | 27014 | LM2904N |
| U2 | 1826-0516 | 4 | 1 | V REF 10.5 | 27014 | LH0070-1H |
| U3 | 1826-0072 | 9 | 1 | IC OP AMP LOW-BIAS-H-IMPD 10.99 | 07263 | UA208M |
| XF1 | 1251-1556 | 7 | 2 | CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ | 28480 | 1251-1556 |
| V1 | 10811-60108 | 7 | 1 | CRYSTAL-10MHZ W/R20 TEMP SET (REPAIR ONLY) | 28480 | 10811-60108 |
| | 2260-0009 | 3 | 1 | NUT-HEX-W/LKWR 4-40-THD .094-IN-THK | 00000 | ORDER BY DESCRIPTION |

## Table 6-1. Replaceable Parts (Continued)

| Reference Designation | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| | | | | **10811A/B CIRCUIT BOARD MISCELLANEOUS PARTS** | | |
| | 1200-0868 | 5 | 1 | SOCKET-STRP 7-CONT DIP-SLDR | 28480 | 1200-0868 |
| | 0360-1244 | 0 | 3 | TERMINAL-SPCL FEEDTHRU | 28480 | 0360-1244 |
| | 3050-0588 | 9 | 1 | WASHER-FL NM NO. 6 145-IN-ID .23-IN-OD | 28480 | 3050-0588 |
| | 0360-1682 | 0 | 2 | TERMINAL-STUD SGL-TUR PRESS-MTG | 28480 | 0360-1682 |
| | 10811-40002 | 4 | 1 | FOAM SHEET-(BELOW OVEN CONTROLLER ASSY) | 28480 | 10811-40002 |
| | | | | **10811A/B TRANSISTOR MOUNTING HARDWARE** | | |
| | 2200-0103 | 2 | | SCREW 4-40 .250 | 28480 | 2200-0103 |
| | 2190-0004 | 2 | | WASHER, FLAT | 28480 | 2190-0004 |
| | 3050-0756 | 2 | | NYLON INSULATOR | 28480 | 3050-0756 |
| | 0340-0864 | 2 | | TRANSISTOR INSULATOR | 28480 | 0340-0864 |
| | | | | **10811A/B MASS ASSEMBLY AND COVERS** | | |
| MP1 | 10811-60106 | 1 | | OVEN MASS ASS. W/THERMISTOR | 28480 | 10811-60106 |
| MP2 | 10811-20202 | 1 | | MASS COVER W/XISTOR CUT-OUTS | 28480 | 10811-20202 |
| MP3 | 10811-20203 | 1 | | MASS COVER W/TUNING CAP HOLE | 28480 | 10811-20203 |
| | 0520-0166 | 8 | | SCREW | 28480 | 0520-0166 |
| | | | | **10811A MECHANICAL PARTS** | | |
| MP4 | 10811-20206 | 1 | | OUTER HOUSING (FOAMED) | 28480 | 10811-20212 |
| MP5 | 10811-20211 | 1 | | BOTTOM COVER | 28480 | 10811-20211 |
| MP6 | 10811-40001 | 1 | | FOAM COOKIE UNDER BOT COV | 28480 | 10811-40001 |
| | | | | **10811A MISCELLANEOUS PARTS** | | |
| | 3030-0827 | 2 | | SCREWS FOR P.C. CONNECTOR | 28480 | 3030-0827 |
| | 2200-0101 | 3 | | SCREWS FOR BOTTOM COVER | 28480 | 2200-0101 |
| | 7120-7912 | 1 | | INFO LABEL 10811A | 28480 | 7120-7912 |
| | 7120-0331 | 1 | | INFO LABEL 10811-60101 | 28480 | 7121-0331 |
| | | | | **10811B MECHANICAL PARTS** | | |
| MP7 | 10811-20205 | 1 | | OUTER HOUSING (FOAMED) | 28480 | 10811-20213 |
| MP8 | 10811-60107 | 1 | | BOTTOM COVER COMPLETE | 28480 | 10811-60107 |
| MP9 | 1250-0911 | 1 | | EFC SHORTING CONNECTOR | 28480 | 1250-0911 |
| | | | | **10811B MISCELLANEOUS PARTS** | | |
| | 2200-0164 | 4 | | SCREW 4-40 .188 TOP | 28480 | 2200-0164 |
| | 7120-7911 | 1 | | INFO LABEL "FREQ ADJ." | 28480 | 7120-7911 |
| | 7120-6299 | 1 | | INFO LABEL HOUSING | 28480 | 7120-6299 |
| | 05060-6116 | 1 | | ADAPTOR MICON-BNC* | 28480 | 05060-6116 |
| | | | | *MICON TO BNC ADAPTOR NOT SUPPLIED. PART NUMBER FOR REFERENCE ONLY. | | |

**Table 6-2. Manufacturers Code List**

| MFR. NO. | MANUFACTURER NAME | ADDRESS | ZIP CODE |
|---|---|---|---|
| 00000 | ANY SATISFACTORY SUPPLIER | | |
| 03888 | KDI PYROFILM CORP | WHIPPANY, NJ | 07981 |
| 04713 | MOTOROLA SEMICONDUCTOR PRODUCTS | PHOENIX, AZ | 85062 |
| 07263 | FAIRCHILD SEMICONDUCTOR DIV | MOUNTAIN VIEW, CA | 94042 |
| 24546 | CORNING GLASS WORKS (BRADFORD) | BRADFORD, PA | 16701 |
| 25088 | SIEMENS CORP | ISELIN, NJ | 08830 |
| 27014 | NATIONAL SEMICONDUCTOR CORP | SANTA CLARA, CA | 95051 |
| 28480 | HEWLETT-PACKARD CO CORPORATE HQ | PALO ALTO, CA | 94304 |
| 30983 | MEPCO/ELECTRA CORP | SAN DIEGO, CA | 92121 |
| 51642 | CENTRE ENGINEERING INC | STATE COLLEGE, PA | 16801 |
| 72982 | ERIE TECHNOLOGICAL PRODUCTS INC | ERIE, PA | 16512 |

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# SECTION VII

# MANUAL CHANGES

## *7-1. INTRODUCTION*

7-2. This section contains information necessary to adapt this manual to apply to older instruments.

## *7-3. MANUAL CHANGES*

7-4. This manual applies directly to Model 10811A/*B* Quartz Crystal Oscillators with serial prefix number 2028.

## *7-5. NEWER INSTRUMENTS*

7-6. As engineering changes are made, newer instruments may have serial prefix numbers higher than those listed on the title page of this manual. The manuals for these instruments will be supplied with "Manual Changes" pages containing the required information to update the manual. Replace affected pages or modify existing manual information as described in the "Manual Changes" pages. See Section VI of this manual for a description of board identification. If the series number etched or stamped on any circuit board or circuit board assembly is higher than the above serial prefix number, "Manual Changes" pages should accompany the manual.

7-7. If the "Manual Change" pages are missing from any HP manual, the information can be supplied by any Hewlett-Packard Sales and Service Office listed at the back of this manual.

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# SECTION VIII

# SERVICE

## *8-1. INTRODUCTION*

8-2. This section contains theory of operation, a detailed troubleshooting procedure, and a schematic diagram.

## *8-3. SCHEMATIC DIAGRAM SYMBOLS AND REFERENCE DESIGNATORS*

8-4. Figure 8-1 shows the symbols used in the schematic diagram. At the bottom of Figure 8-1, the system for reference designators, assemblies, and subassemblies is shown.

## *8-5. REFERENCE DESIGNATORS*

## 8-6. Theory of Operation

8-7. The overall theory of operation for the 10811A/B starts with paragraph 8-9. The detailed theory of operation starts with paragraph 8-13.

## *8-8. OVERALL BLOCK DIAGRAM THEORY*

8-9. The 10811A/B Quartz Crystal Oscillator is an extremely stable, compact, low-power source of 10 MHz. The crystal, along with the oscillator, circuit buffer amplifier, and oven control circuits are all mounted inside a thermally insulated housing.

8-10. A detailed block diagram of the 10811A/B oscillator is shown in Figure 8-2.

8-11. The 10811A/B oscillator is divided into three sections with each section connected by a .010-inch thick flexible circuit. Three small circuit boards are bonded to the flexible circuit to provide support in the areas where components are located. The arrangement allows the unit to be easily disassembled and operated in the disassembled state on the service bench.

8-12. The three sections can be divided into the following subsections (Figure 8-2):

1. Main Oscillator
2. Automatic Gain Control
   Voltage Reference (+5.7V and +6.4V)
   Output Impedance Matching Buffer
3. Output Buffer Amplifier
   Oven Controller

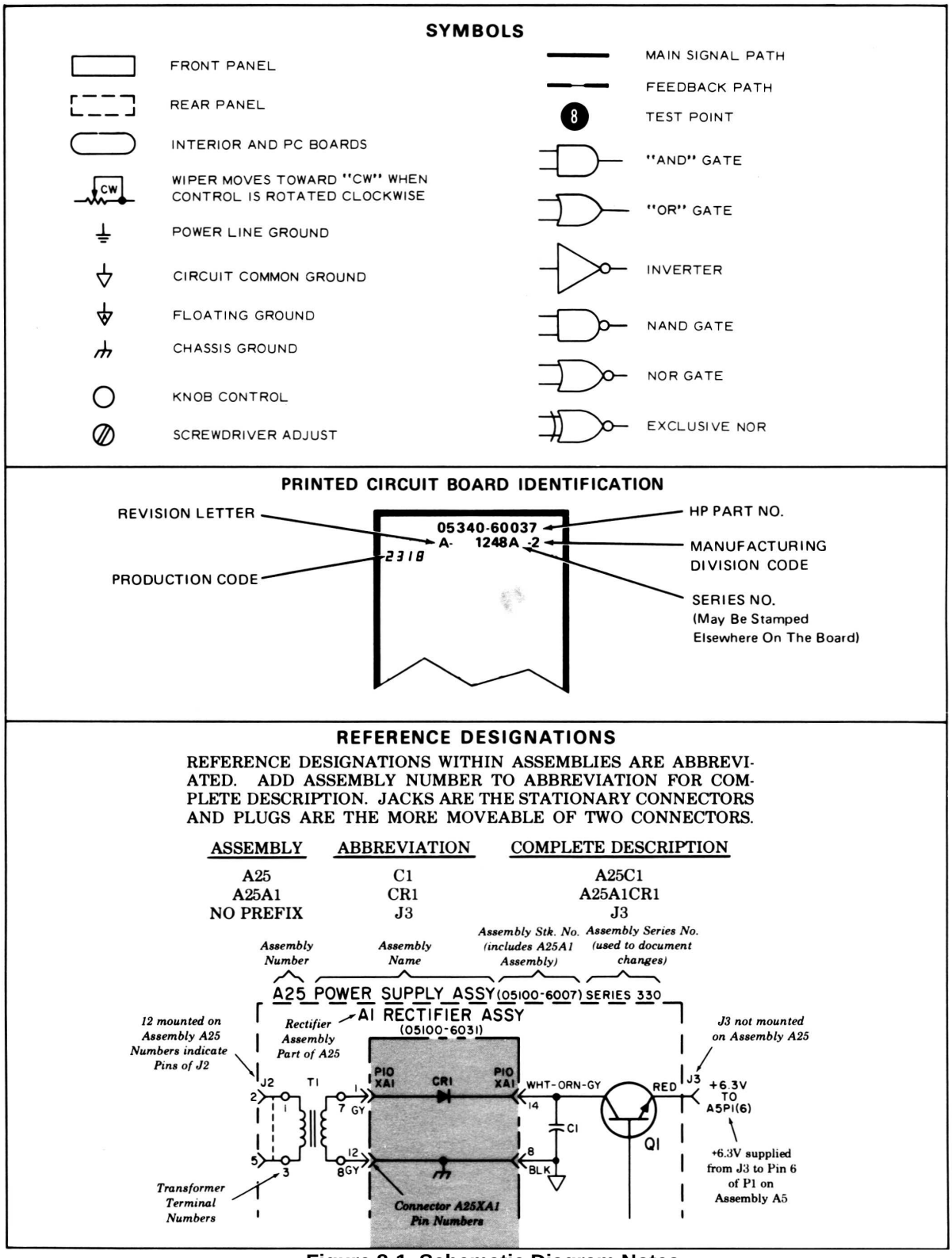



**Figure 8-1. Schematic Diagram Notes**

- A GROUND POINT FOR TESTING OSCILLATOR. AGC,OUTPUT AMPLIFIER AND VOLTAGE REFERENCE.
- B GROUND POINT FOR TESTING OVEN CONTROLLER.
- B GROUND POINT FOR TESTING OVEN CONTROLLER.
- A AND B GROUNDS MAY BE TIED TOGETHER OR FLOATED AT DIFFERENT POTENTIALS EXTERNAL TO THE OSCILLATOR.

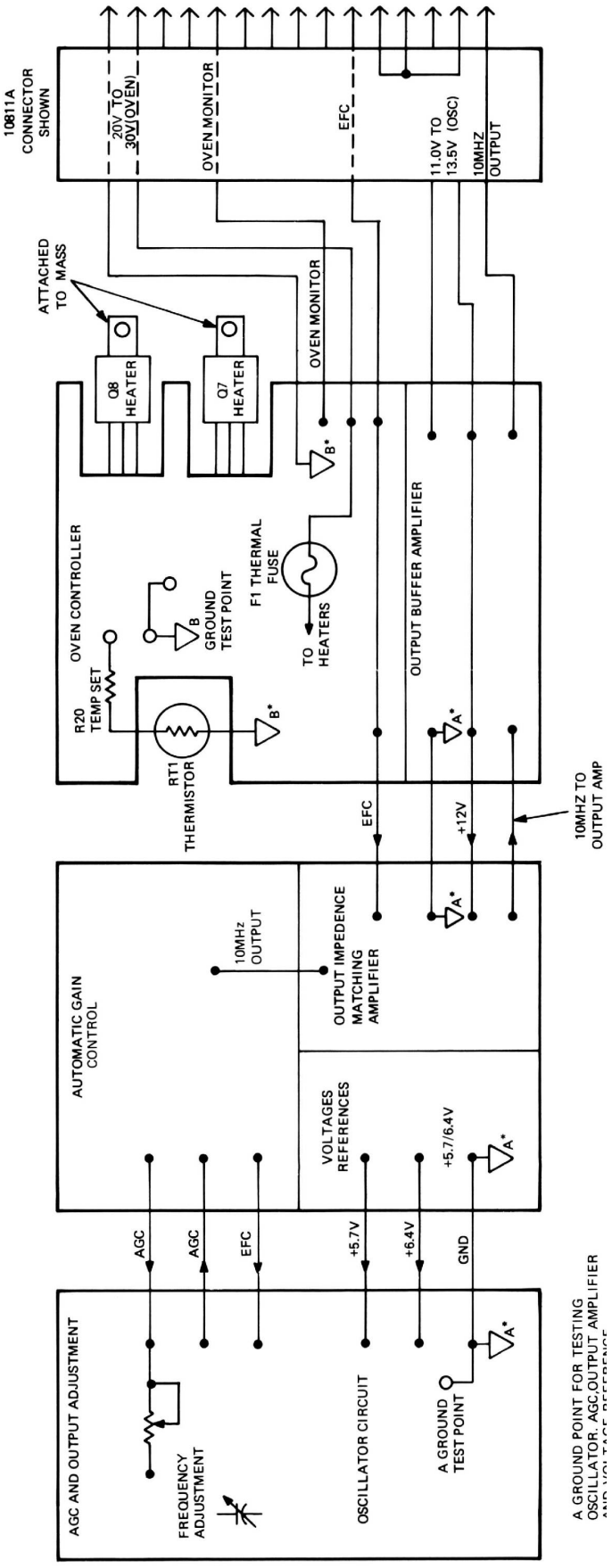



**Figure 8-2. 10811A/B Overall Block Diagram**

## 8-13. MAIN OSCILLATOR THEORY OF OPERATION

8-14. The 10811A/B oscillator is a Colpitts-type crystal oscillator which uses the crystal as the series inductor. Figure 8-3A shows the basic block diagram of a Colpitts-type oscillator. Figure 8-3B shows the basic equivalent components of the oscillator.

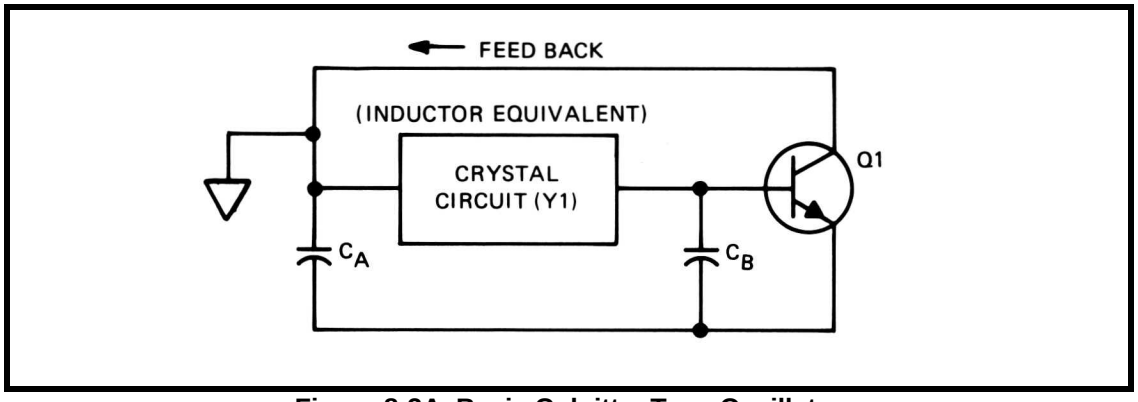



**Figure 8-3A. Basic Colpitts- Type Oscillator**

r

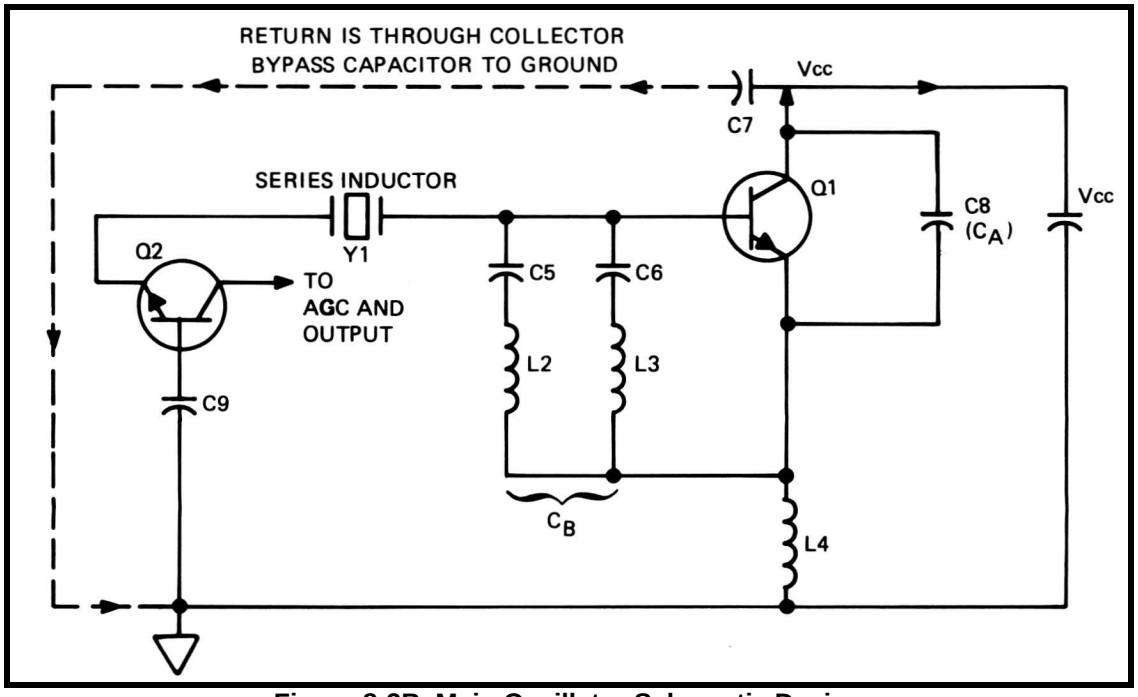



**Figure 8-3B. Main Oscillator Schematic Design**

8-15. Comparing Figure 8-3A and 8-3B, we find Y1 is the inductor, capacitor CA is C8 and CB is the combination of C5, L2, C6, and L3. C5 is a dc blocking capacitor. Its reactance is very low, so the combination of these components can be redrawn as in Figure 8-4. The crystal Y1 is a "third overtone" crystal and is operated at 10 MHz. To keep the circuit from oscillating at the crystal's fundamental, or at a different overtone, the mode suppression network of C5, L2, C6, L3 appears capacitive only at frequencies between 9 MHz and 10.5 MHz. Below and above this frequency range, the network appears inductive. This does not allow the proper phase shift around the loop and thus suppresses oscillations at all frequencies other than 10 MHz. It should be noted that any reactance in series with the crystal will cause a change in frequency.

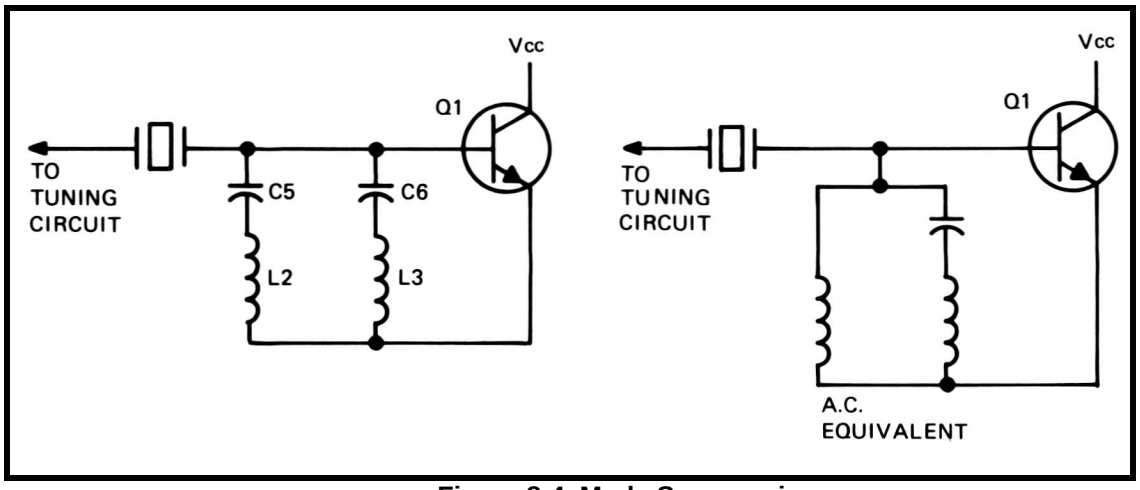



**Figure 8-4. Mode Suppression**

8-16. Figure 8-5 show the equivalent crystal circuits with the tuning capacitor C1.

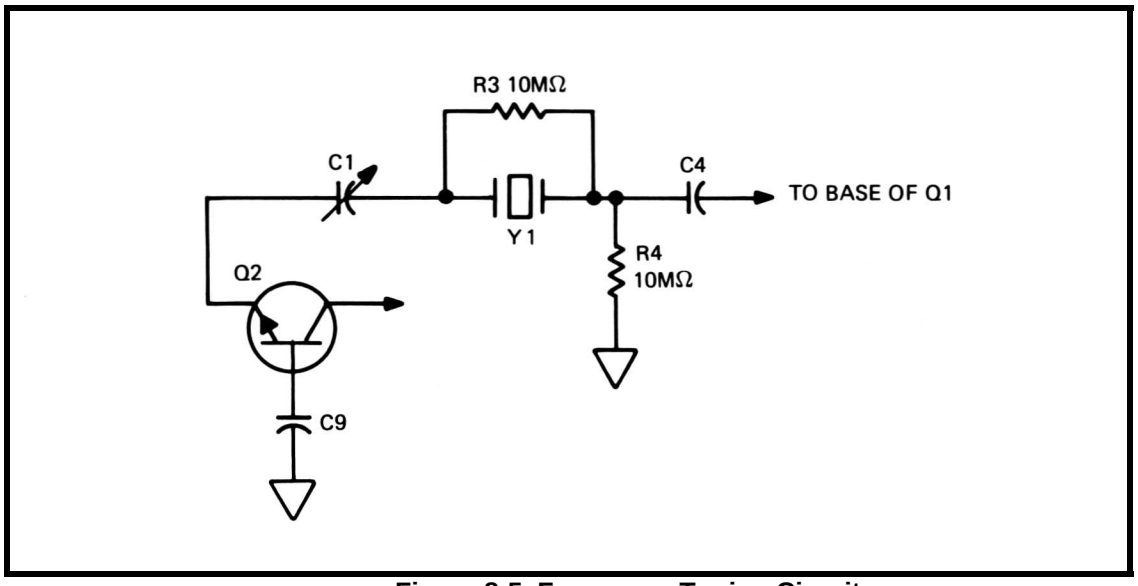



**Figure 8-5. Frequency Tuning Circuit**

8-17. C1 tuning capacitor is available from the top of the oscillator outer housing. The change in reactance of C1 allows the oscillator's frequency to be varied over a 20 Hz (2 X $10^{-6}$) range. C9 and C4 are dc blocking capacitors.

## *8-18. ELECTRONIC FREQUENCY CONTROL (EFC)*

8-19. To allow for a fine tuning control, a varactor (CR1) is added in parallel with C1 tuning capacitor. See Figure 8-6. The varactor's capacitance depends on the dc voltage applied to it (reverse bias). The HC voltage range is +5 volts to -5 volts, giving a fine tuning range of ≈1 Hz (1 X$10^{-7}$). Since one side of the varactor is tied to a reference (6.4V), a full +5 volts applied to the HC input will still keep CR1 reverse biased. C2 and C3 are again dc blocking capacitors to keep the HC current from flowing in to the crystal circuit. Note: if the HC input is not used, it must be connected to ground to keep any noise from modulating the HC line and causing frequency changes.

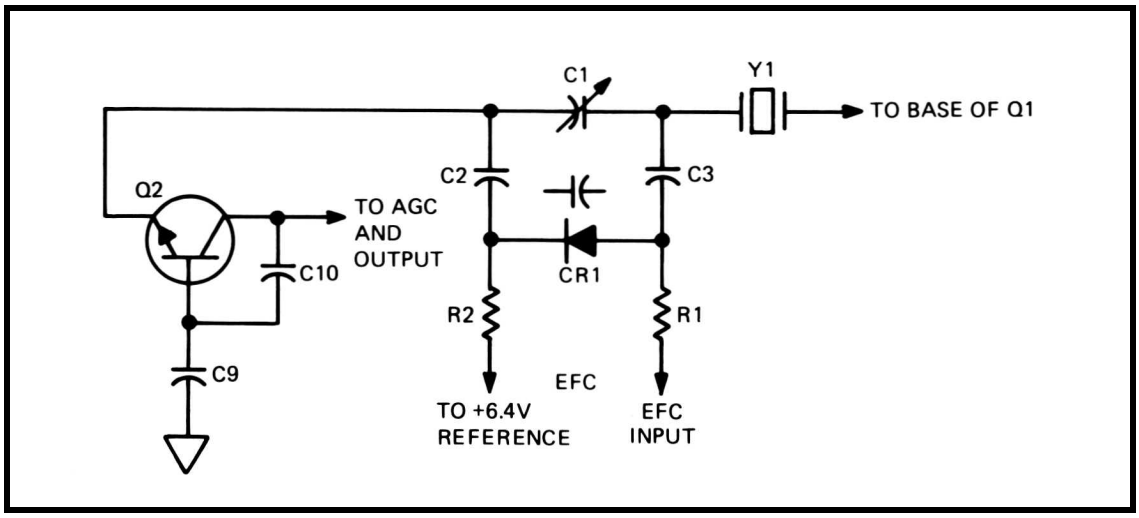



**Figure 8-6. EFC**

## *8-20. AUTOMATIC GAIN CONTROL (AGC)*

8-21. The output for the AGC (and output amplifiers, discussed later) is taken across capacitor C10, and is applied to Q3. Since C10 is effectively in series with the crystal, the current passing through the crystal also passes through C10. The voltage across C10 is therefore proportional to the current through the crystal. As the output of the oscillator changes, the output of the peak detector circuit changes. This change in the AGC voltage changes the voltage applied to the base of Q1 and stops the impending output voltage change. A peak detector circuit formed by C12, CU, CR4 and CR5 is used to develop a dc voltage to control the crystal current. This negative control voltage forms the lower half of a voltage divider for the base of Q1 (R6 and R7). Controlling the bias current and the gain of Q1. Thus AGC action controls the output signal level. (See Figure 8-7).

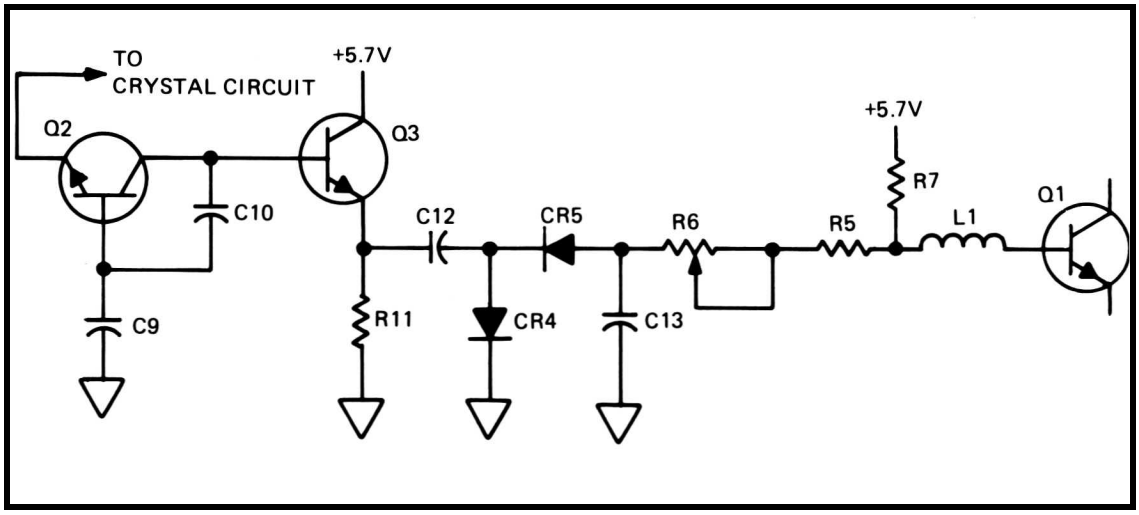



**Figure 8-7. Automatic Gain Control (AGC)**

8-22. By adjusting the AGC voltage with R6 the amplitude for the output (at the base of Q3) can be set. R5 sets the AGC limit when R6 is at its minimum resistance.

## 8-23. RF OUTPUT IMPEDANCE MATCHING AND OUTPUT BUFFER

8-24. The signal for the output amplifiers is taken from the same point as the AGC (across C10). The voltage is buffered by Q5 which is an impedance matching stage. Resistors R14 and R15 set the dc bias level while C14 allows the ac to bypass R14. The signal is then applied to the output buffer stage of Q9. Resistor R40 provides the 50Ω source impedance when transformed by T1. Typical gain from Q9 base to collector is approximately 2. See Figure 8-8.

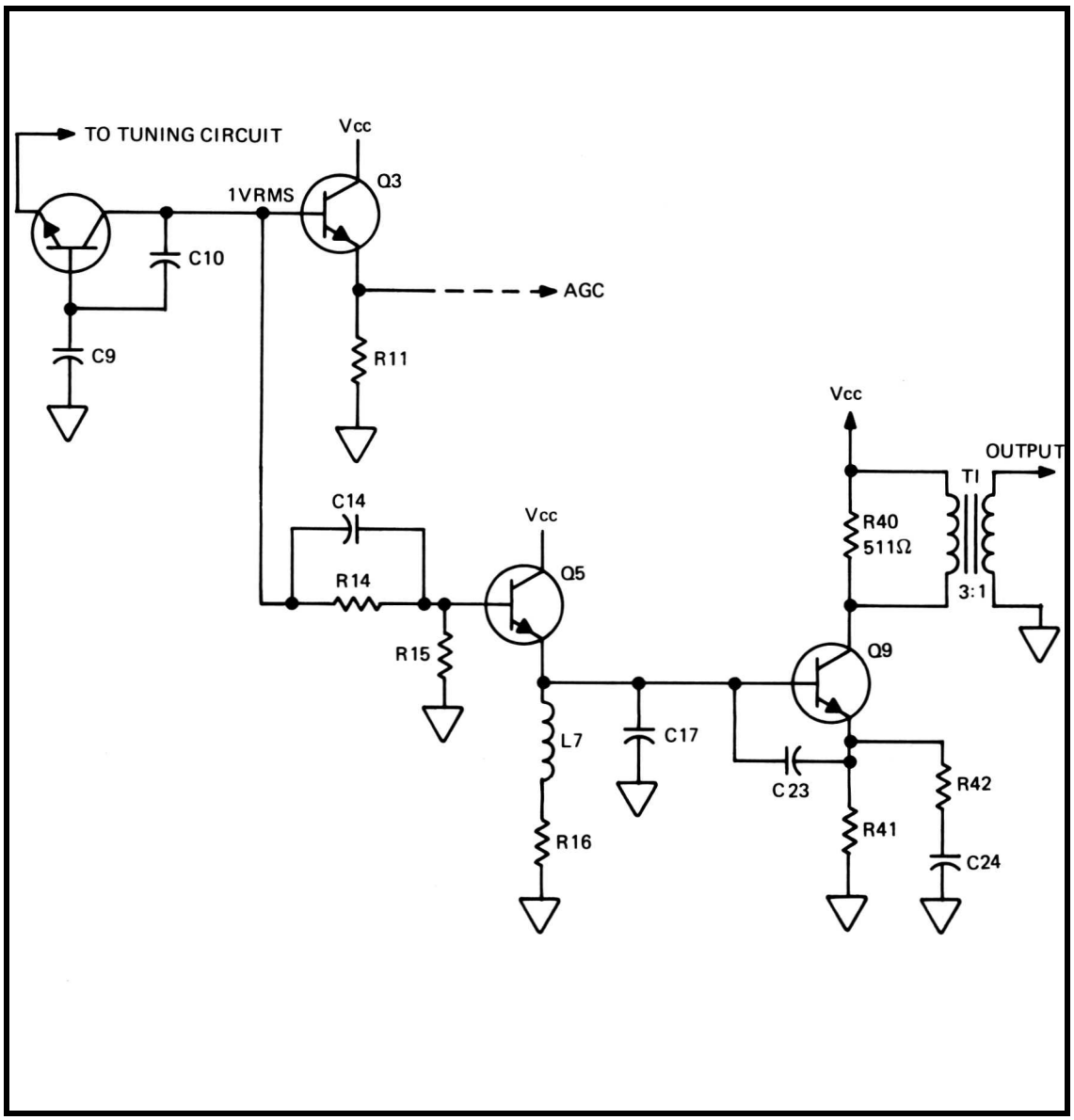



**Figure 8-8. Output Amplifiers**

## 8-25. VOLTAGE REFERENCES (5.7V AND 6.4V)

8-26. Constant current diode CR2 feeds 1 mA to zener diode CR3 providing 6AV dc for the EFC varactor reference. R12 and C15 form a filter to attenuate noise from the zener diode. R13 provides current limiting for Q5 if the 5.7V line is shorted. See Figure 8-9.

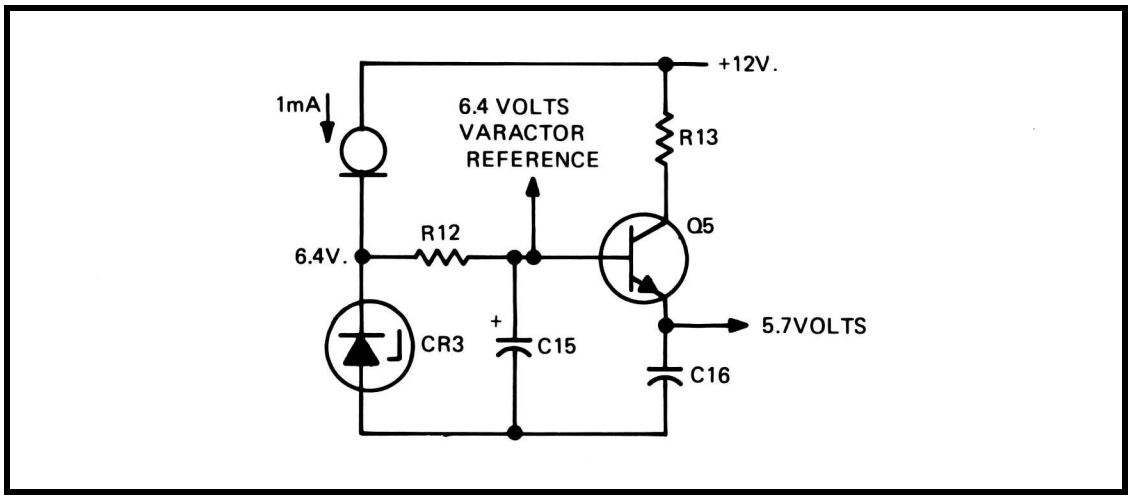



**Figure 8-9. Voltage References**

## *8-27. OVEN HEATER AND CONTROLLER THEORY*

NOTE

In the following theory of operation the term OVEN MASS will be used to describe the cast aluminum block in which the crystal and crystal electronics are located. The exploded view of the oscillator shows the oven mass.

8-28. The purpose of the oven is to shield the oscillator crystal and electronics from normal ambient temperature changes. The oven controller does this by maintaining a constant oven temperature which is higher than the highest expected ambient temperature.

8-29. Three main blocks make up the oven circuits. See *Figure 8-10.*

1. Thermistor
2. Amplifier (controller)
3. Heaters

8-30. In the 10811A/B oven, a thermistor (RT1) is secured with epoxy into a hole in the oven mass. U3 is the amplifier and Q7 (not shown) and Q8 are the heaters. It is the thermistor that senses the oven mass temperature. Since it is in one leg of the bridge circuit, when the mass temperature changes slightly, a voltage change occurs across the bridge (RT1, R18, R19, R20, R21). Amplifier U3 boosts this voltage change and then uses it to control the current through Q7 and Q8. The current flowing through transistors Q7 and Q8 causes power dissipation in the form of heat, and it is this heat that warms the oven mass. Therefore, when the mass temperature starts to change, the heaters are told to adjust their power to cancel the impending temperature change.

8-31. WARM-UP: GENERAL OPERATION. If the oscillator has been off for several hours, the mass and thermistor will be at the ambient temperature. Assuming this is below the normal oven operating temperature (80 to 84°C) the resistance at the thermistor RT1 is higher than that of R18 + R20 and therefore $V_1 > V_2$. This causes the output of U3 to be ≈ (Vcc - 1.5V) and supply base current to Q8 through Q6. A separate circuit limits the collector current of Q8 and is described later. As the oven mass warms up, the thermistor's resistance gets lower causing both V2 and V1 to lower (V2 lowers because Vo lowers due to RT1 getting smaller). V1 decreases at a faster rate than V2 and eventually $V_1 = V_2$ when RT1 = R20 + R18. At this time, the oven controller "cuts back" and begins to operate in a linear mode, adjusting the collector current in Q8 (and therefore the power dissipated in Q7 and Q8) to keep the oven precisely at its set temperature.

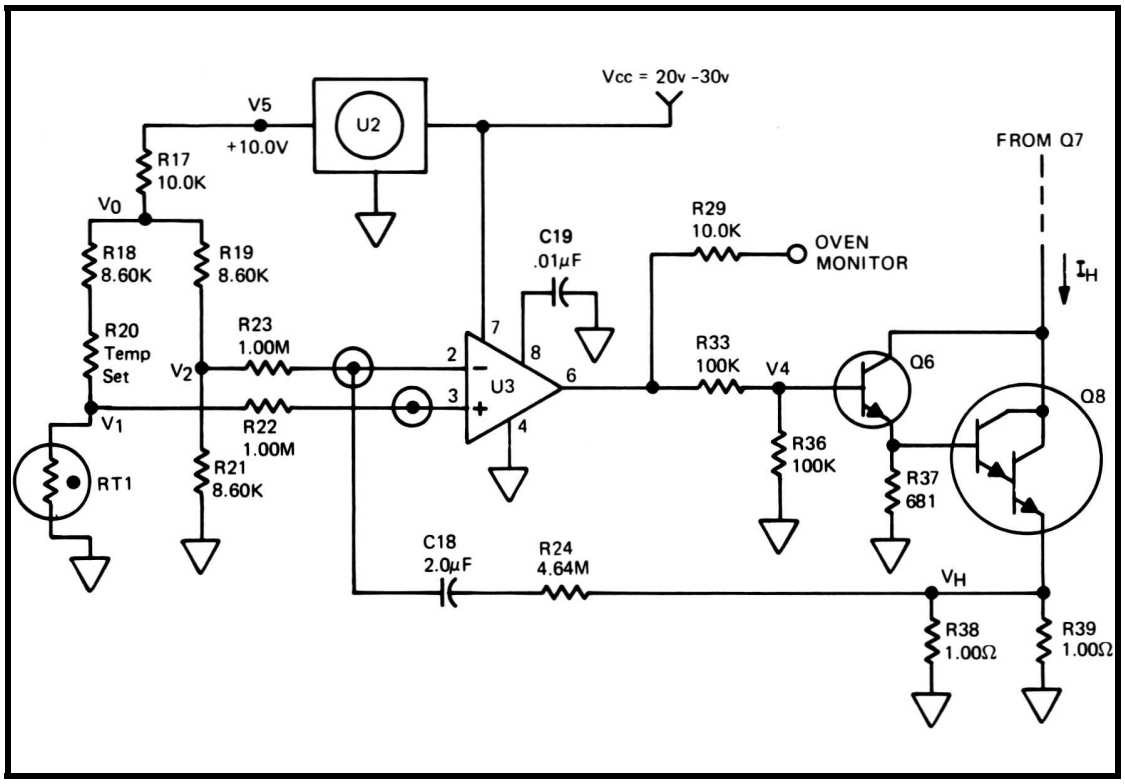



**Figure 8-10. Oven Control Circuits**

8-32. The purpose of R17 is mainly to reduce the power dissipated in the thermistor which causes it to self-heat above the oven operating temperature.

8-33. R38 and R39 in parallel provide a means of sensing the heater current, rH. During warm-up, the voltage across them, VH, is used in the current limit circuit (described later). During normal, linear operation, VH is essentially the feedback point for the oven controller loop.

8-34. Q6 is necessary primarily for the condition when the oscillator has been stored at -55°C. Since U3 (at -55°C) cannot supply enough base current for Q8, Q6 gives the added current gain required.

## *8-35. PRECISION VOLTAGE REFERENCE*

8-36. U2 is a 10.0V voltage reference. It provides a stable voltage source for the bridge and U1. A change in the bridge reference voltage changes the voltage across the thermistor and hence, the power it dissipates. See Figure 8-10.

## *8-37. OVEN CONTROLLER TURN-ON CURRENT LIMITING*

*8-38.* *Figure* 8-11 shows the turn-on current limiting circuit. From an initial turn-on condition the thermistor senses the oven temperature to be low. To correct this situation the amplifier attempts to drive heavy amounts of current through Q7 and Q8 heaters. If allowed to continue this way, excessive current will flow; much more than is practical or necessary for warm-up. Amplifier U1 and associated components limit the current during warm-up to a practical value. When Vcc is applied to the oven, U1B forces VH to equal V3 by sinking the base current from Q6. By sensing Vcc, the circuit transforms the heater transistors into what appears to be a fixed heater resistance of 47Ω typical.

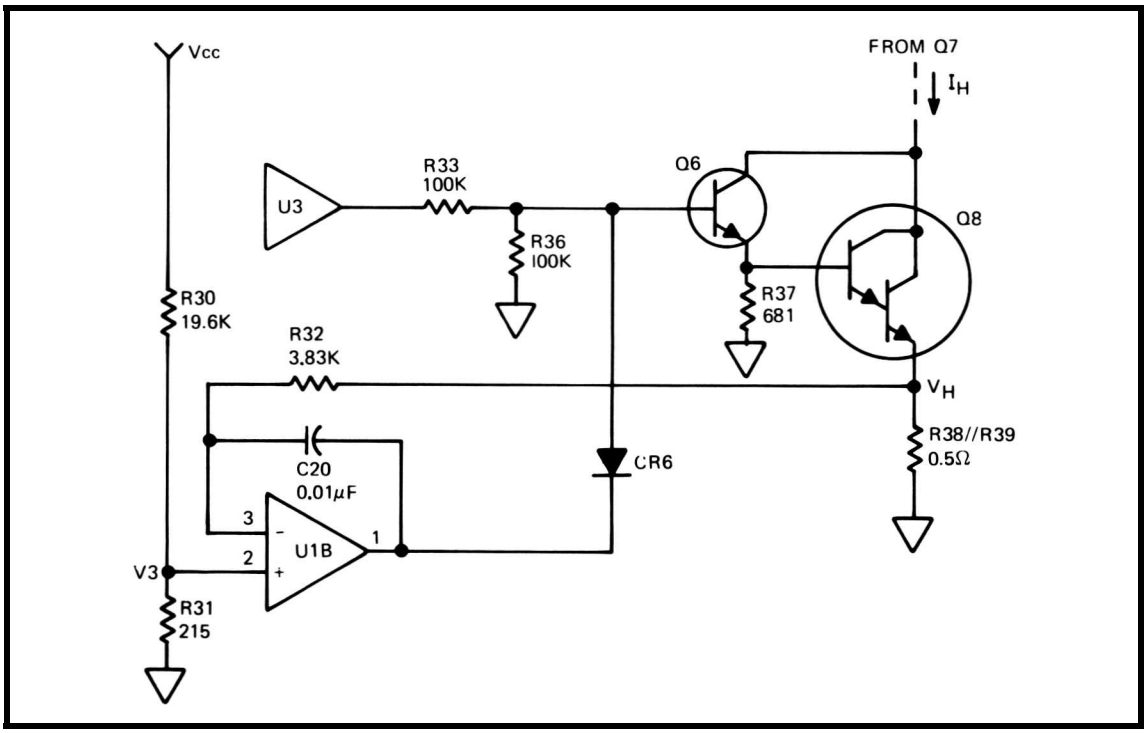



**Figure 8-11. Turn-on Current Limit Circuit**

## *8-39. HEATER TRANSISTOR BALANCE*

8-40. Because heater transistors Q7 and Q8 are not equally spaced from the crystal, it is necessary to offset the power dissipation between the two transistors. Figure 8-12 shows a simplified schematic of this circuit. Amplifier U1A references a voltage divider across Vcc (R25, R26) and a divider referenced to the mid-point between the heater transistors. From this U1A controls the base current of Q7 to insure the Voltage at the mid-point between the heater transistors is a constant percentage of Vcc (V4 ≈ 0.57 Vcc ± 2%).

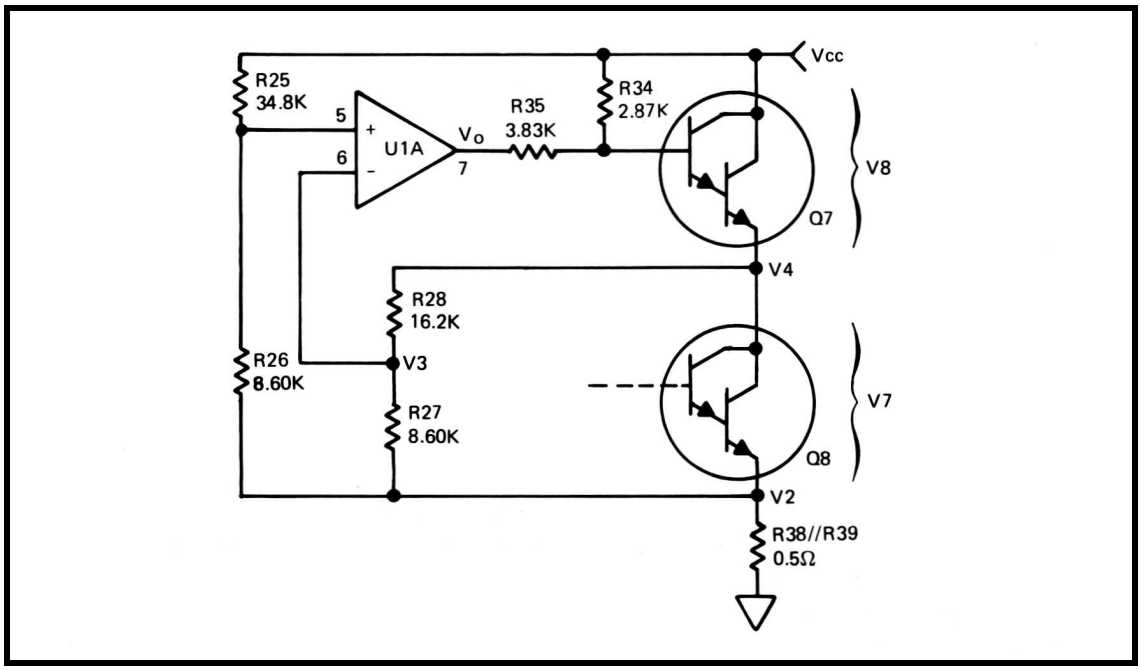



**Figure 8-12. Heater Transistor Balance Circuit.**

# *8-41. REPAIR AND TROUBLESHOOTING*

## 8-42. Inspection

8-43. The 10811A/B should be inspected for indications of mechanical and electrical defects. Electronic components that show signs of overheating, leakage, frayed insulation, and other signs of deterioration should be checked and a thorough investigation of the associated circuitry should be made to verify proper operation. Mechanical parts should be inspected for excessive wear, looseness, misalignment, corrosion, and other signs of deterioration.

**CAUTION**

**Proper static handling techniques must be employed when servicing semiconductor products. The voltage susceptibility of all IC and transistor families is well below levels commonly found in service environments. Exercise care and observe standard static precautions.**

# *8-44. REPAIR*

## 8-45. Printed Circuit Component Replacement

8-46. To prevent damage to the plating and the replacement component, apply heat sparingly, and work carefully. See CAUTION below.

## 8-47. Replacing Integrated Circuits

8-48. Following are two recommended methods of replacing integrated circuits:

a. SOLDER GOBBLER. This is the best method. Solder is removed from board by a soldering iron with a hollow tip connected to a vacuum source.

b. CLIP-OUT. Clip the leads as close to the component as possible. With a soldering iron and long nose pliers, carefully remove the leads from each hole. Then clean the holes.

**CAUTION**

The flex circuitry used in the 10811A/B oscillator requires special attention to soldering iron tip temperature and the length of time heat is applied. A low wattage (≈25W) iron with a temperature control should be used. The tip temperature should be held below 500°C. Care should be taken to be sure that the iron is not held on the circuit longer than necessary. Components should be removed by clipping the leads and then gently removing them. Do not use force when removing components. Following these precautions will insure that repairs can be easily made without damaging the flex circuit. Also, components should not be arbitrarily removed for troubleshooting or replacement unless there is reasonable confidence in the component's failure.

**WARNING**

THE OSCILLATOR'S INTERNAL OVEN MASS TEMPERATURE MAY BE AS HIGH AS 85°C (185°F). TO AVOID SERIOUS BURNS DO NOT REMOVE OSCILLATOR CIRCUITS AND/OR OVEN MASS ASSEMBLY FROM THE OUTER CAN UNTIL THE OSCILLATOR HAS SUFFICIENTLY COOLED (APPROXIMATELY ONE HOUR WITH BOTTOM COVER AND FOAM INSULATOR REMOVED). THE OUTER HOUSING TEMPERATURE IS NOT A RELIABLE INDICATION OF THE INTERNAL TEMPERATURE.

8-49. The troubleshooting is arranged to allow the technician to quickly find the defective component(s) without unnecessary removal of components.

## *8-50. TROUBLESHOOTING*

8-51. Failures in the 10811A/B can be divided into two sections:

1. Failure of the oscillator's circuits.
2. Failure in the oven controller circuits.

8-52. Failures in the oscillator circuits can be divided into the following problems:

1. No output.
2. Output amplitude is too low or high.
3. Output is distorted (contains excessive harmonics).
4. Output is off frequency (high or low).
5. Output has excessive noise or frequency stability does not meet specifications.

8-53. Poor frequency stability can be difficult to troubleshoot, and many times the oscillator is not at fault. Environmental conditions can affect stability and should be ruled out first.

8-54. Failures in the oven circuitry can be divided into the following problems:

1. No oven current (heat).
2. Excessive oven current (>600 mA).
3. Oven does not cut back after warm-up (this will open the thermal fuse if allowed to continue).
4. Oven does not regulate at the proper temperature. (This can be the cause for poor frequency stability).

8-55. Since the main oscillator and oven control power supply inputs are separate from each other, the defective circuit can be operated without applying power to the complete oscillator.

8-56. Determine which section is defective (oven or oscillator circuit), then proceed as described in the following troubleshooting section. The two circuits can be investigated separately.

1. Remove top cover and insulator described in:
   a. 10811A paragraphs 8-59.
   b. 10811B paragraphs 8-59, step 4.

**CAUTION**

**With the cover and foam insulator removed to thermal fuse cannot protect the oven circuit from thermal runaway. Caution should be used at all times.**

## *8-57. DISASSEMBLY FOR TROUBLESHOOTING AND REPAIR*

8-58. Perform steps 1 through 3 for the 10811A oscillator and steps 4 and 5 for the 10811B oscillator. Once these steps are completed, follow steps 6 through 10 for both oscillators.

8-59. For the 10811A Oscillator:

Step 1. Remove the three screws securing the bottom cover to the outer housing, and remove bottom cover.

Step 2. Remove the two screws securing the pc edge connector to the outer housing.

Step 3. Remove the foam sheet to expose the oven controller circuit board.

If troubleshooting the oven controller, stop here and go to paragraph 8-69. Go to Step 6 only if the trouble is in the oscillator circuit.

**For the 10811B oscillator:**

Step 4. Remove the four screws securing the cover to the outer housing.

Step 5. Disconnect the flexible circuit attached to the cover from the 7-pin connector mounted to the oven controller circuit board.

If troubleshooting the oven controller, stop here and go to paragraph 8-69. Continue only if the trouble is in the oscillator circuit.

The following steps will be performed for both oscillators.

Step 6. Using a long, small diameter tool, remove the complete oscillator assembly by inserting the tool into the tuning capacitor access hole (labeled FREQ. ADJUST) and pushing on the capacitor until the circuit can be grasped and removed freely.

**CAUTION**

10811A Only

**Do not remove the circuits by pulling on the edge connector or flexible circuit. Damage to the flexible circuit may occur.**

Step 7. Using a Pozidriv screwdriver , remove the two screws securing the heater transistors to the oven mass. Remove the washers and transistor insulators.

NOTE

When reassembling the oven mass the heater transistor screws must be tightened to a torque of 44 Newton meters (5 in.-lbs.)

Step 8. Tilt the oven controller assembly back and remove the foam insulator between the oven controller assembly and the oven mass. Be careful not to break the two black thermistor wires attached to the oven controller assembly.

Step 9. Remove the eight screws (four each side) securing the covers to the oven mass assembly.

Step 10. Use two of the screws from each cover (removed in Step 9) to secure the boards to the mass for troubleshooting.

8-60. Go to paragraph 8-84, Oscillator Troubleshooting. When reassembling unit, reverse the above procedure.

## 8-61. SPECIAL TEST CONNECTOR FOR 10811A

8-62. The following paragraphs describe a special 15-pin connector for use in troubleshooting, alignment and testing of the 10811A. The connector provides the following (See *Figure* 8-13):

a. Two separate input leads for the oscillator circuits power and the oven heaters and controller circuits.
b. 10 MHz output through a female BNC.
c. Oven monitor output for connection to a voltmeter.
d. HC input connection to ground.

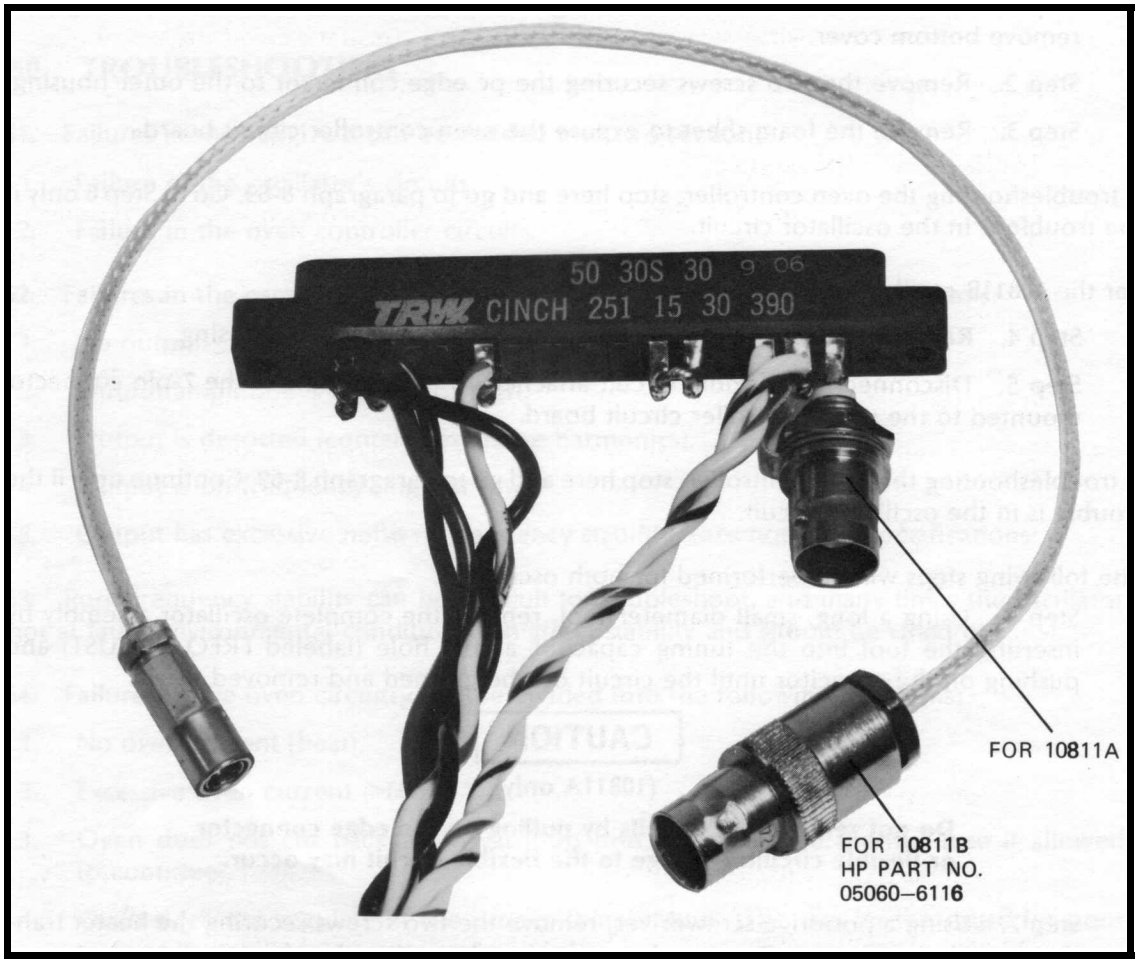



**Figure 8-13. 10811A/B Special Test Connector**

8-63. The following parts are required to construct the special test connector:

a. 15-pin pc board connector (HP part number 1251-0494).
b. 6 banana plugs (HP part number 1251-0124).
c. BNC female connector with ground lug and nut.

| | |
|---|---|
| BNC connector | 1250-0083 |
| Ground lug | 0360-0024 |
| lock washer | 2190-0016 |
| Nut | 2950-0001 |

d. Approximately 6-feet of 24-gauge wire.

e. Labels for banana plugs.

8-64. To construct the connector:

a. Solder the center pin of the BNC connector to pin 1(A) of the printed circuit connector; this is the 10MHz output signal.
b. Bend the BNC ground lug to align with pin 2(B) of the printed circuit connector.
c. Solder one end of a 2-foot length of wire to pin 2(B) of the printed circuit connector. Also solder the BNC ground lug to pin 2(B). This is the oscillator circuit common.
d. Solder one end of a 2-foot length of wire to pin 3(C) of the printed circuit connector. This is the oscillator (+) supply.
e. Connect a jumper wire between pins 5(E) and 6(F). This terminates the HC input.
f. Solder one end of a 2-foot length of wire to pin 11(M). This is oven monitor output.
g. Solder one end of a 2-foot length of wire to pin 14(R) of the printed circuit connector. This is the oven (+) supply.
h. Solder one end of two 2-foot lengths of wire to pin 15(S) of the printed circuit connector. This is the oven common.
i. Twist together one of the two wires connected to pin 15(S) and the wire connected to pin 14(R). These are the oven controller power supply inputs.
j. Twist together the remaining wire connected to 15(S) and the wire connected to pin 11(M). This is the oven monitor output.
k. Twist together the two wires connected to pins 2(B) and 3(C). These are the oscillator supply input.
l. Connect one banana plug to the free end of each wire.
m. Label each banana plug as follows:

| **Wire connected to:** | **Label as:** |
|---|---|
| pin 2(B) | oscillator supply (-) |
| pin 3(C) | oscillator supply (+) |
| pin 11 (M) | oven monitor (+) |
| pin 14(R) | oven supply (+) |
| pin 15(S) two wire | oven supply (-) |
| | oven monitor (-) |

n. Inspect the connector for poor solder joints, bent or damaged pins. Double check the labeling of the banana plugs to be sure the polarity markings are correct. If the voltages are connected the wrong way, damage to the 10811A may occur.

## *8-65. SPECIAL CABLE FOR THE 10811B.*

8-66. A micon to BNC adaptor cable is available for the 10MHz output signal. Order HP Part Number 05060-6116 (see Figure 8-13).

## *8-67. SPECIAL PARTS REPLACEMENT CONSIDERATIONS*

8-68. Several mechanical parts and components must be replaced as a pair or require special consideration. They are:

**a.** Oven mass assembly and thermistor: If the thermistor (RT1) is found to be defective, the thermistor and oven mass assembly must be replaced as one item, HP Part Number 10811-60106. **Do not attempt to replace the thermistor alone.**

b. Crystal and Temperature Set Resistor: The replacement crystal for Y1 will be accompanied by the **required temperature set resistor (R20)** for the oven. This resistor must be installed with the new crystal. The crystal and R20 can be ordered using HP Part Number 10811-60108. If the temperature set resistor is found to be defective only, it must be replaced with the same value and tolerance. If the temperature set resistor (R20) is unreadable, the value required can be determined by finding the oven temperature value marked on the crystal (Y1). The required resistor can then be determined from *Table* 8-1. When Y1 is replaced, the nut which secures it to the oven mass should be tightened to a torque of 44 newton-metres (5 in.-lbs.). This will insure maximum heat transfer without overstressing the crystal package.

**c.** 10811B Bottom cover: If any part of the 10811B bottom cover is found to be defective, the complete bottom cover must be replaced (HP Part Number 10811-60107). Once the insulating foam is attached to the bottom cover, feedthroughs and terminals cannot be replaced without impairing the heat insulating abilities of the bottom cover. **Do not attempt to repair the cover or replace the flex circuit.**

**Table 8-1. Temperature Set Resistor List.**

| OVEN TEMP °C | RESISTOR VALUE | PART NUMBER |
|---|---|---|
| 80.0 | 1.33K | 0698-7239 |
| 80.1 | 1.29K | 0698-6981 |
| 80.2 | 1.25K | 0698-6973 |
| 80.3 | 1.21K | 0698-7238 |
| 80.4 | 1.18K | 0698-3512 |
| 80.5 | 1.15K | 0698-4469 |
| 80.6 | 1.10K | 0698-7237 |
| 80.7 | 1.07K | 0698-4196 |
| 80.8 | 1.04K | 0698-6970 |
| 80.9 | 1.00K | 0698-7236 |
| 81.0 | 968 | 0698-0096 |
| 81.1 | 931 | 0698-4465 |
| 81.2 | 909 | 0698-7235 |
| 81.3 | 866 | 0698-3495 |
| 81.4 | 825 | 0698-7234 |
| 81.5 | 787 | 0698-4014 |
| 81.6 | 750 | 0698-7233 |
| 81.7 | 715 | 0698-3700 |
| 81.8 | 681 | 0698-7232 |
| 81.9 | 649 | 0698-4460 |
| 82.0 | 619 | 0698-7231 |
| 82.1 | 600 | 0757-1100 |
| 82.2 | 562 | 0698-7230 |
| 82.3 | 511 | 0698-7229 |
| 82.4 | 500 | 0698-5852 |
| 82.5 | 464 | 0698-7228 |
| 82.6 | 422 | 0698-7227 |
| 82.7 | 383 | 0698-7226 |
| 82.8 | 348 | 0698-7225 |
| 82.9 | 316 | 0698-7224 |
| 83.0 | 287 | 0698-7223 |
| 83.1 | 261 | 0698-7222 |
| 83.2 | 215 | 0698-7220 |
| 83.3 | 196 | 0698-7219 |
| 83.4 | 162 | 0698-7217 |
| 83.5 | 121 | 0698-7214 |
| 83.6 | 100 | 0698-7212 |
| 83.7 | 61.9 | 0698-7207 |
| 83.8 | 34.8 | 0698-7201 |
| 83.9 | 0 | jumper |
| 84.0 | 0 | jumper |

d. Oven heater transistors Q7 and Q8: The replacement transistors for Q7 and Q8 have formed leads for easy installation (Part Number 10811-80001). Holding screws for Q7 and Q8 must also be torqued to a specific force of 44 newton-metres (5 in.-lbs.). There are several available Pozidriv ⊕ torquing screwdrivers.

## *8-69. OVEN CONTROLLER TROUBLESHOOTING*

## 8-70. General

8-71. The oven controller section consists of three major circuits and a 10V voltage reference for increased stability of sensitive circuits. Figure 8-14 shows the major circuits and active components involved in their operation.

8-72. The temperature sense circuit monitors the temperature of the oven mass and reduces the power drawn by the oven heater transistors when the oven mass has reached operating temperature. After power cut-back, this circuit monitors the oven mass temperature and controls the power in the heaters to maintain the constant temperature. The thermistor (RT1) has a negative temperature coefficient. At room temperature the thermistor resistance is approximately 100K ohms, while at operating temperature (-82°C) the resistance is approximately 9K ohms. Shorting the thermistor to oven common makes the oven mass appear too hot to the temperature sense circuit. This in turn causes the temperature sense circuit to shut off power to the oven heaters. This technique is used in the troubleshooting procedure.

8-73. The warm-up current limit circuit controls the maximum current the oven may draw during warm-up (380 to 490 mA with 20V dc oven input). This circuit is only active during the warm-up phase of the oven circuit operation.

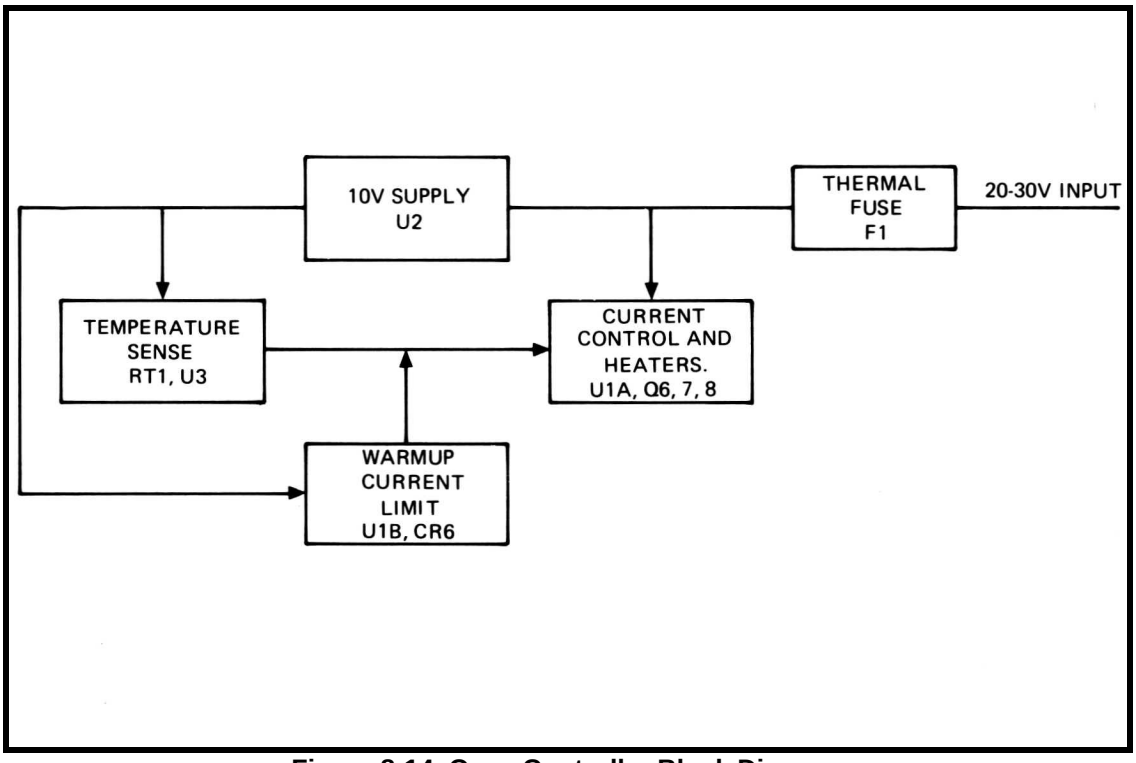



**Figure 8-14. Oven Controller Block Diagram**

## 8-74. Normal Operation

8-75. When the oven is tested under normal conditions (-25°C ambient temperature) it will initially draw 380 to 490 mA. After 5 to 10 minutes the oven current will start to drop. Over the next 10 to 15 minutes the oven current will fall to the 60 to 150 mA range where it will stabilize. The oven circuit should not oscillate.

**WARNING**

DO NOT OPERATE THE OVEN CIRCUITS WHEN THE OVEN MASS IS OUTSIDE OF THE OSCILLATOR INSULATED HOUSING. DOING SO WILL OVERHEAT THE OSCILLATOR CIRCUITS INSIDE THE OVEN MASS AND CAUSE PERMANENT DAMAGE. ALL OVEN TEST POINTS ARE AVAILABLE WITH THE OVEN MASS AND OVEN CONTROLLER CIRCUIT INSIDE THE HOUSING.

WHEN OSCILLATOR COVER AND INSULATOR ARE REMOVED THERMAL FUSE WILL NOT PROTECT CIRCUIT FROM OVERHEATING. APPLY OVEN POWER ONLY WHEN ACTUALLY MAKING MEASUREMENTS FOR TROUBLESHOOTING OR AS DIRECTED IN TROUBLESHOOTING TREE, TABLE 8-2.

## *8-76. TROUBLESHOOTING*

8-77. Table 8-2 is a troubleshooting' tree for the oven circuits. The troubleshooting procedure separates the different functional circuits by monitoring the oven supply current during different operating conditions. For example, if the warm-up current is excessive, this indicates a trouble in the warm-up current limit circuit, or the current control and heater circuit. If shorting the thermistor reduces the current being drawn from the power supply, this indicates the current control circuit is operating and the problem is most likely in the warm-up current limit circuit.

8-78. As with most troubleshooting trees this is intended to be a guide to the trouble area. It is not a substitute for technical skill in isolating the faulty components.

8-79. Table 8-3 (next to schematic diagram) gives normal circuit voltages during warm-up, operation, and when thermistor RT1 is shorted to ground. Use this table during troubleshooting.

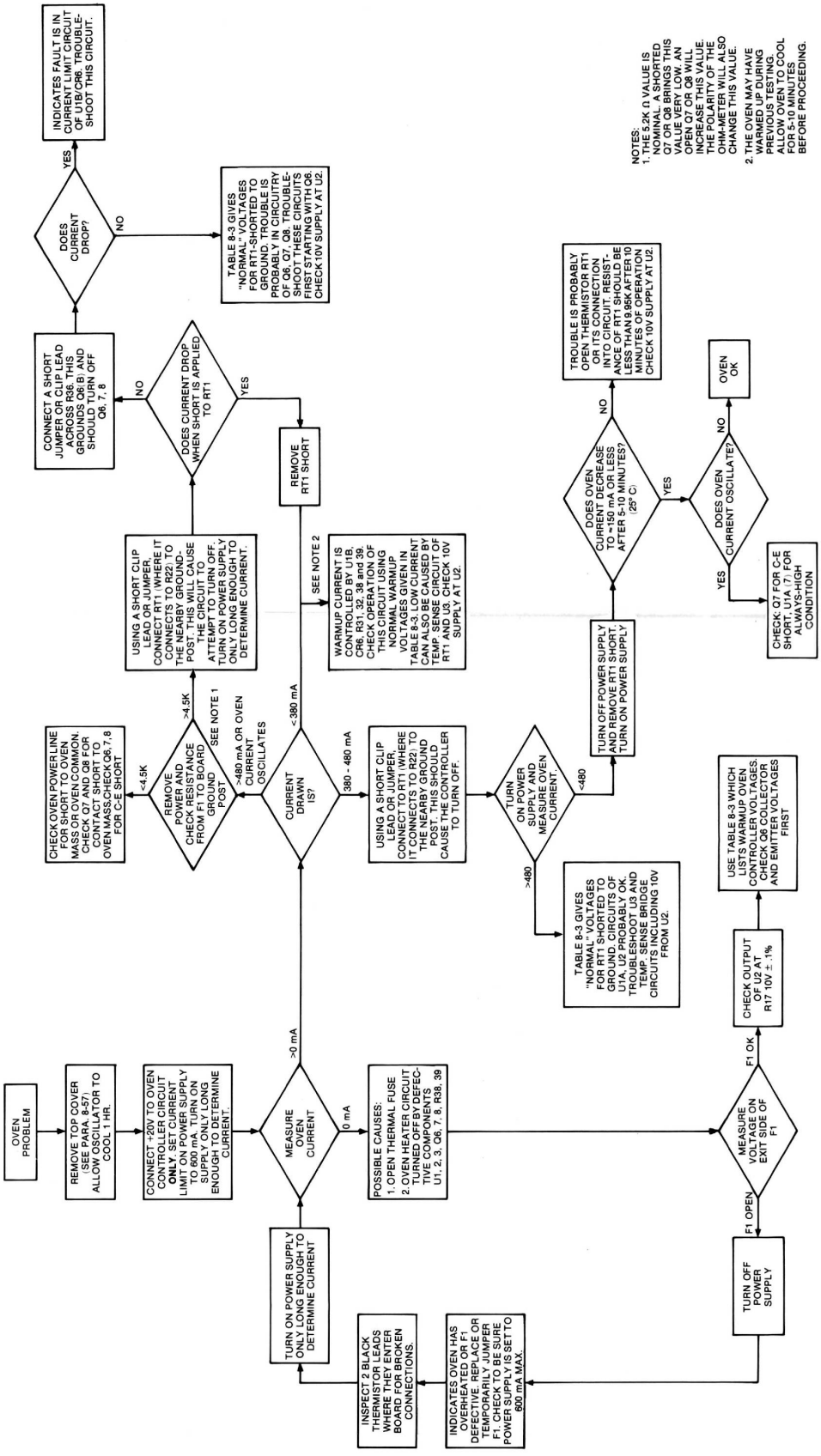
## 8-80. Troubleshooting Cautions

8-81. When oven current is excessive, turn on the power supply only long enough to make the necessary measurements. Do not leave power on if the oven is drawing excessive current. With the housing cover and foam insulator removed, the thermal fuse (F1) cannot protect the circuits in the oven mass from overheating and damage.

## 8-82. Flex Damage

8-83. If a tear in the flex circuit occurs, the tear can continue until a trace is broken. To stop a tear, use a pair of scissors and cut around the tear. DO NOT CUT A SHARP CORNER as this will cause a stress concentration allowing the tear to start again. A hole-punch may also be used. Punch a hole in the flex so as to remove the forward end of the tear.

## Table 8-2. Oven Controller Troubleshooting Tree


OVEN PROBLEM
REMOVE TOP COVER (SEE PARA. 8-57). ALLOW OSCILLATOR TO COOL 1 HR.
CONNECT 120V TO OVEN CONTROL CIRCUIT ONLY. SET CURRENT LIMIT ON POWER SUPPLY TO 600 mA. TURN ON SUPPLY ONLY LONG ENOUGH TO DETERMINE CURRENT.
MEASURE OVEN CURRENT
>0 mA
0 mA
POSSIBLE CAUSES: 1. OPEN THERMAL FUSE 2. OVEN HEATER CIRCUIT TURNED OFF BY DEFECTIVE COMPONENTS U1, 2, 3, Q6, 7, 8, R38, 39
TURN ON POWER SUPPLY ONLY LONG ENOUGH TO DETERMINE CURRENT
INSPECT 2 BLACK THERMISTOR LEADS WHERE THEY ENTER BOARD FOR BROKEN CONNECTIONS.
INDICATES OVEN HAS OVERHEATED OR F1 DEFECTIVE. REPLACE OR TEMPORARILY JUMPER F1. CHECK TO BE SURE POWER SUPPLY IS SET TO 600 mA MAX.
MEASURE VOLTAGE ON EXIT SIDE OF F1
F1 OPEN
F1 OK
TURN OFF POWER SUPPLY
CHECK OUTPUT OF U2 AT R17 10V ± .1%
USE TABLE 8-3 WHICH LISTS WARMUP OVEN CONTROLLER VOLTAGES. CHECK Q6 COLLECTOR AND EMITTER VOLTAGES FIRST
CURRENT DRAWN IS?
<380 mA
380 - 480 mA
>480 mA OR OVEN CURRENT OSCILLATES
USING A SHORT CLIP LEAD OR JUMPER, CONNECT RT1 (WHERE IT CONNECTS TO R22) TO THE NEARBY GROUND-POST. THIS WILL CAUSE THE CIRCUIT TO ATTEMPT TO TURN OFF. TURN ON POWER SUPPLY ONLY LONG ENOUGH TO DETERMINE CURRENT.
REMOVE POWER AND CHECK RESISTANCE FROM F1 TO BOARD GROUND POST
SEE NOTE 1
>4.5K
<4.5K
CHECK OVEN POWER LINE FOR SHORT TO OVEN MASS OR OVEN COMMON. CHECK Q7 AND Q8 FOR CONTACT SHORT TO OVEN MASS. CHECK Q6, 7, 8 FOR C-E SHORT
USING A SHORT CLIP LEAD OR JUMPER, CONNECT RT1 WHERE IT CONNECTS TO R22 TO THE NEARBY GROUND POST. THIS SHOULD CAUSE THE CONTROLLER TO TURN OFF.
TURN ON POWER SUPPLY AND MEASURE OVEN CURRENT.
<480
>480
TABLE 8-3 GIVES "NORMAL" VOLTAGES FOR RT1 SHORTED TO GROUND. CIRCUITS OF U1A, U2 PROBABLY OK. TROUBLESHOOT U3 AND TEMP. SENSE BRIDGE CIRCUITS INCLUDING 10V FROM U2.
TURN OFF POWER SUPPLY AND REMOVE RT1 SHORT. TURN ON POWER SUPPLY
DOES OVEN CURRENT DECREASE TO ~150 mA OR LESS AFTER 5-10 MINUTES? (25° C)
NO
YES
TROUBLE IS PROBABLY OPEN THERMISTOR RT1 OR T1S CONNECTION INTO CIRCUIT. RESISTANCE OF RT1 SHOULD BE LESS THAN 9.95K AFTER 10 MINUTES OF OPERATION. CHECK 10V SUPPLY AT U2.
DOES OVEN CURRENT OSCILLATE?
NO
YES
OVEN OK
CHECK Q7 FOR C-E SHORT, U1A, 7 FOR ALWAYS-HIGH CONDITION
WARMUP CURRENT IS CONTROLLED BY U1B, CR6, R31, 32, 38 and 39. CHECK OPERATION OF THIS CIRCUIT USING NORMAL WARMUP VOLTAGES GIVEN IN TABLE 8-3. IF CURRENT CANNOT BE CONTROLLED BY TEMP. SENSE CIRCUIT OF RT1 AND U3, CHECK 10V SUPPLY AT U2.
SEE NOTE 2
REMOVE RT1 SHORT
DOES CURRENT DROP WHEN SHORT IS APPLIED TO RT1
NO
YES
CONNECT A SHORT JUMPER OR CLIP LEAD ACROSS R36. THIS GROUNDS Q6 (B) AND SHOULD TURN OFF Q6, 7, 8
DOES CURRENT DROP?
YES
NO
INDICATES FAULT IS IN CURRENT LIMIT CIRCUIT OF U1B/CR6. TROUBLE-SHOOT THIS CIRCUIT.
TABLE 8-3 GIVES "NORMAL" VOLTAGES FOR RT1-SHORTED TO GROUND. TROUBLE IS PROBABLY IN CIRCUITRY OF Q6, Q7, Q8. TROUBLE-SHOOT THESE CIRCUITS FIRST STARTING WITH Q8. CHECK 10V SUPPLY AT U2.
NOTES:
1. THE 5.2K Ω VALUE IS NOMINAL. A SHORTED Q7 OR Q8 BRINGS THIS VALUE VERY LOW. AN OPEN Q7 OR Q8 WILL INCREASE THIS VALUE. THE POLARITY OF THE OHM-METER WILL ALSO CHANGE THIS VALUE.
2. THE OVEN MAY HAVE WARMED UP DURING PREVIOUS TESTING. ALLOW OVEN TO COOL FOR 5-10 MINUTES BEFORE PROCEEDING.

## 8-84. OSCILLATOR TROUBLESHOOTING

8-85. The oscillator circuits are relatively simple and straightforward. The following paragraphs will briefly describe the major circuit areas, a troubleshooting outline, and some helpful suggestions to make the troubleshooting process easier. The oscillator consists of four sections. They are:

1. Oscillator Q1, Q2, and associated circuitry.
2. AGC Q3, CR4, CR5, and R6.
3. Output circuit Q5, Q9.
4. 5.7V power supply CR2, CR3, and Q4.

The oscillator is the signal source. Its output level is controlled by the AGC. The 5.7V power supply provides an extra-stable clean voltage source for the oscillator circuits. The output circuits provide a high level signal capable of driving a 50 to 1K ohm load.

## 8-86. NORMAL OPERATION

8-87. The output of the oscillator circuit at Q2(C) is a 10 MHz undistorted sine wave; with an amplitude of approximately 2.8V p-p. The AGC voltage (measured at CR5-C13 junction) is approximately -1.5V. The 10 MHz signal passes through Q5 to Q9(B) at about the same level. The voltage gain of amplifier Q5 (base to collector) is approximately 2 with a 50-ohm load on the output. The output of transformer T1 is approximately 1.5V p-p. All10 MHz signals found in the 10811A/B will be undistorted sine waves unless otherwise noted in *Table* 8-4 (next to the schematic diagram).

## 8-88. OSCILLATOR TROUBLESHOOTING TECHNIQUES

8-89. When troubleshooting the oscillator section, remove the oven mass from the housing and the covers from the oven mass as described in paragraph 8-59. Connect 12V to the oscillator section; use special connector described in paragraph 8-61 for 10811A, connect power to T1(1) and oscillator circuit common in 10811B. Set the power supply current limit to 60 mA. **Do not apply power to the oven circuits!**

8-90. Initial troubleshooting and probing should be done on the backside of the boards (trace side) while they are secured to the oven mass (see paragraph 8-59, step 10). This way the circuits are more easily handled. When the fault is isolated to a few components, the unit may then be disassembled for final troubleshooting and repair.

8-91. **Helpful Hints**

1. Most points in the oscillator circuits cannot be measured with a dc voltmeter. The reactance of the voltmeter probe and leads will load the circuit and give false readings. Instead, use an oscilloscope with a high input impedance probe for these measurements. *Table* 8-4 (oscillator section normal voltages) indicates when a dc voltmeter can be used.
2. Before reinstalling the oven mass into the housing, adjust the output amplitude (with R6) to 0.53V into a 50-ohm load. Although this value is slightly below normal, the output will increase slightly when the unit is reassembled and is at normal operating temperatures.
3. If a tear in the flex circuit occurs, go to paragraph 8-82 for repair instructions.

## 8-92. TROUBLESHOOTING INFORMATION

8-93. Symptoms of failures in the oscillator sections will generally fall into one of the following categories:

1. No output.
2. Output amplitude is low or high.
3. Output is distorted (contain excessive harmonics).
4. Excessive drift of output frequency.
5. Time domain frequency stability (short-term stability) does not meet specifications.

8-94. Troubleshooting of these faults will be discussed in the following paragraphs.

8-95. NO OUTPUT. This is usually easy to repair by simple signal tracing. Localized faultfinding (to actual defective component) can be somewhat more difficult if the problem is in the main oscillator circuit (Q1, Q2, and AGC). If the fault appears to be in the oscillator section and does not yield to normal troubleshooting techniques, measure the AGC voltage at the junction of CR5-C13 (see Note 7 on *Table* 8-4, Oscillator Normal Voltages). If this voltage appears normal, the problem may be a defective quartz crystal (Y1). To verify this possibility, obtain a 10 µH (HP Part No. 9100-2265) and a 12 µH inductor (9100-2242). Use the HP numbered parts as these have been tested in the circuit. On the oscillator board, remove the red and blue wires connecting the crystal to the board. Place the 12 µH inductor in place of these wires. With 12V applied to the circuit, adjust the FREQ ADJUST (C1), and amplitude control (R6) for a good sine wave signal.

**NOTE**

At some settings of C1 and/or R6, intermittent oscillations may appear. Some minor adjustment of C1 and/or R6 should clear this. If this fails, replace the 12 µH inductor with the 10 µH inductor and repeat the C1/R6 adjustment.

If replacing the crystal with an inductor produces oscillation, this is a very good indication of a defective crystal. When replacing crystal Y1, read paragraph 8-68(b), Special Parts Considerations. If the circuit will still not oscillate, the problem is most likely one of the oscillator circuit elements.

8-96. OUTPUT AMPLITUDE HIGH OR LOW. Many times this can be cured by the adjustment of R6 as described in paragraph 5-14. If the correct amplitude cannot be obtained with this adjustment, monitor the signal at Q6(C) with an oscilloscope and set R6 to obtain an amplitude of 2.8V p-p. Then check Q5 and Q9 stages. If the R6 adjustment isn't effective, you should suspect the AGC circuitry (Q3, CR4, CR5, C5, C6, R5, R6, R7, or Q1).

8-97. OUTPUT DISTORTION. Check the distortion with a spectrum analyzer (see *Table 4-2* step 2. for procedure). If the distortion products are harmonically related to 10 MHz, trace the signal to the distorting stage. If the distortion is not harmonically related to the 10 MHz output:

1. Check the mode suppression components of L2/C5 and/or L3/C6. These components suppress oscillations at all frequencies other than 10 MHz.
2. Check for spurious oscillations from the amplifier stages and oscillator transistors.

8-98. EXCESSIVE DRIFT OF OUTPUT FREQUENCY. When a quartz crystal oscillator has not been operated for a long period of time, or if it has been subjected to severe thermal or mechanical shock, the oscillator may take some time to stabilize. In most cases, the crystal will drift and then stabilize at or below the specified rate within a few days after being turned on. In isolated cases, depending on the amount of time the oscillator has been off and the environmental conditions it has experienced, the 10811A/B may take up to 1 week to reach the specified aging rate. This should be taken into consideration if the drift rate of the unit is out of specifications. If the unit has had sufficient time to stabilize but is still out of specification, the most likely cause of excessive drift is a defective crystal (Y1). If Y1 is to be replaced, read paragraph 8-68(b). Other possible causes are unstable C3 and/or C8.

8-99. TIME DOMAIN STABILITY (SHORT-TERM STABILITY) OUT OF SPECIFICATION. Measurement of time domain stability is somewhat difficult and exacting. If the 10811A/B fails this test, be sure no signal sources other than the test reference are operating near the measurement system, as these can cause interference with the measurement. Other sources of error are vibration, nearby electrical equipment, poor shielding, or motors that can radiate signals into the 10811A/B. The failure to connect the HC input (to ground) can cause poor frequency stability as can a noisy voltage being used for the EFC control. If another oscillator is available (known to be good), verify the accuracy of the measurement system. This could save considerable troubleshooting time.

8-100. Two other possibilities external to the oscillator are the oven and oscillator power supplies. These must be stable in order for the circuits to function properly. See Table 1-1, Specifications, and paragraph 2-6 for power supply noise requirements.

8-101. When troubleshooting this condition, carefully monitor the output waveform. Check for distortion or intermittent distortion, small amplitude variations (there should be none), or spurious oscillations on the output signal. Use a spectrum analyzer for this test (see Table 4-2, step 3). These symptoms can be more readily traced than small frequency fluctuations.

8-102. Almost any of the circuits can cause poor short-term stability. However, the most probable cause is crystal Y1. Other possible causes are the oven controller circuit (keeps changing temperature) or defective frequency determining components (CR1, C1, C3, C8, or instability in the 5.7V supply). Q1 and Q2 are also good suspects. Instability can also be caused by the AGC circuit, but this is usually visible as output amplitude variations or instability on the output waveform.

8-103. To check oven stability, allow the 10811A/B to operate normally away from drafts or sudden temperature changes. Allow the unit to warm up for at least 1-hour then connect a sensitive recorder or digital voltmeter to the OVEN MONITOR OUTPUT. Once the oven has stabilized, the monitor voltage should not vary more than 100-200 µV when measured over 3- to 4-minute periods. Causes of oven instability are temperature sensing elements RT1, U2, U3, and associated components.

**Table 8-3. Oven Circuit Voltages·**

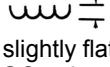
| VOLTAGE POINT | OVEN AT OPERATING TEMP. | OVEN COLD (JUST AFTER TURN-ON) | RT1 GROUNDED |
|---|---|---|---|
| Q6B | 1.6 | 2. | .25 |
| Q6C | 11.4 | 11.4 | 11.4 |
| Q6E | 1. | 1.3 | 0 |
| Q7B | 12.5 | 12.7 | 11.9 |
| Q7C | 20. | 20. | 20. |
| Q7E | 11.4 | 11.4 | 11.4 |
| Q8B | 1. | 1.3 | 0 |
| Q8C | 11.4 | 11.4 | 11.4 |
| Q8E | .07 | .23 | 0 |
| U1 Pin 1 | 8.9 | 1.8 | 8.9 |
| U1 Pin 2 | .07 | .23 | 0 |
| U1 Pin 3 | .2 | .23 | .2 |
| U1 Pin 5 | 4. | 4.1 | 3.8 |
| U1 Pin 6 | 4. | 4.1 | 3.8 |
| U1 Pin 7 | 3.3 | 4.8 | 1.5 |
| U2 Pin 2 | 10. | 10. | 10. |
| U3 Pin 6 | 3.5 | 19.0 | .5 |

*Voltage readings taken with oven supply voltage of 20V dc and insulating foam and cover removed. Voltages are approximate and will vary slightly from unit-to-unit.

**Table 8-4. Oscillator Section Normal Voltages (see Notes 1, 2, 3)**

| VOLTAGE POINT | NORMAL VOLTAGES | | REMARKS |
|---|---|---|---|
| | AC (p-p) | DC | |
| C3/R3 | 1 to 4 | - | Note 8 |
| CR5/C13 | - | -1.5 | Notes 4 and 7 |
| CR3(C) | 0 | 6.3 | Note 4 |
| Q1(B) | 1 | .75 | Note 8 |
| Q1(C) | 0 | 5.5 | Note 4 |
| Q1(E) | .9 | .03 | Note 8 |
| Q2(B) | 0 | 2.7 | Note 4 |
| Q2(C) | 2.7 | 5.6 | Note 8 |
| Q2(E) | .06 | 2 | Notes 4 and 5 |
| Q3(B) | 2.7 | 5.6 | Note 8 |
| Q3(C) | 0 | 11.8 | Note 4 |
| Q3(E) | 2.4 | 4.9 | Notes 4 and 6 |
| Q4(B) | 0 | 6.3 | Note 4 |
| Q4(C) | 0 | 10.3 | Note 4 |
| Q4(E) | 0 | 5.6 | Note 4 |
| Q5(B) | 2.7 | 3.1 | Note 8 |
| Q5(C) | 0 | 11.8 | Notes 8 and 9 |
| Q5(E) | 2.8 | 2.6 | Note 8 |
| Q9(B) | 2.8 | 2.8 | Note 8, 9 |
| Q9(C) | 5.1 | 11.8 | Note 8, 9 |
| Q9(E) | 2.5 | 1.9 | Note 8 |

NOTES:

1. All voltages taken with 12V oscillator supply.
2. Voltages are approximate and will vary slightly from unit-to-unit.
3. All ac voltages are sine waves except Q2(E) and Q3(E).
4. This dc voltage may be measured with a standard dc voltmeter. All other voltages should be measured with an oscilloscope and high impedance probe to minimize circuit loading.
5. Waveform is  .06V.
6. Waveform is slightly flattened on the bottom.
7. This is the AGC voltage. Value shown is nominal with oscillator operating. If the oscillator is not oscillating, the AGC voltage will be -+2.5V.
8. Measure both ac and dc voltages with an oscilloscope and a high impedance probe to minimize circuit loading.
9. AC voltage at Q9(C) measured with 50-ohm load on the output.

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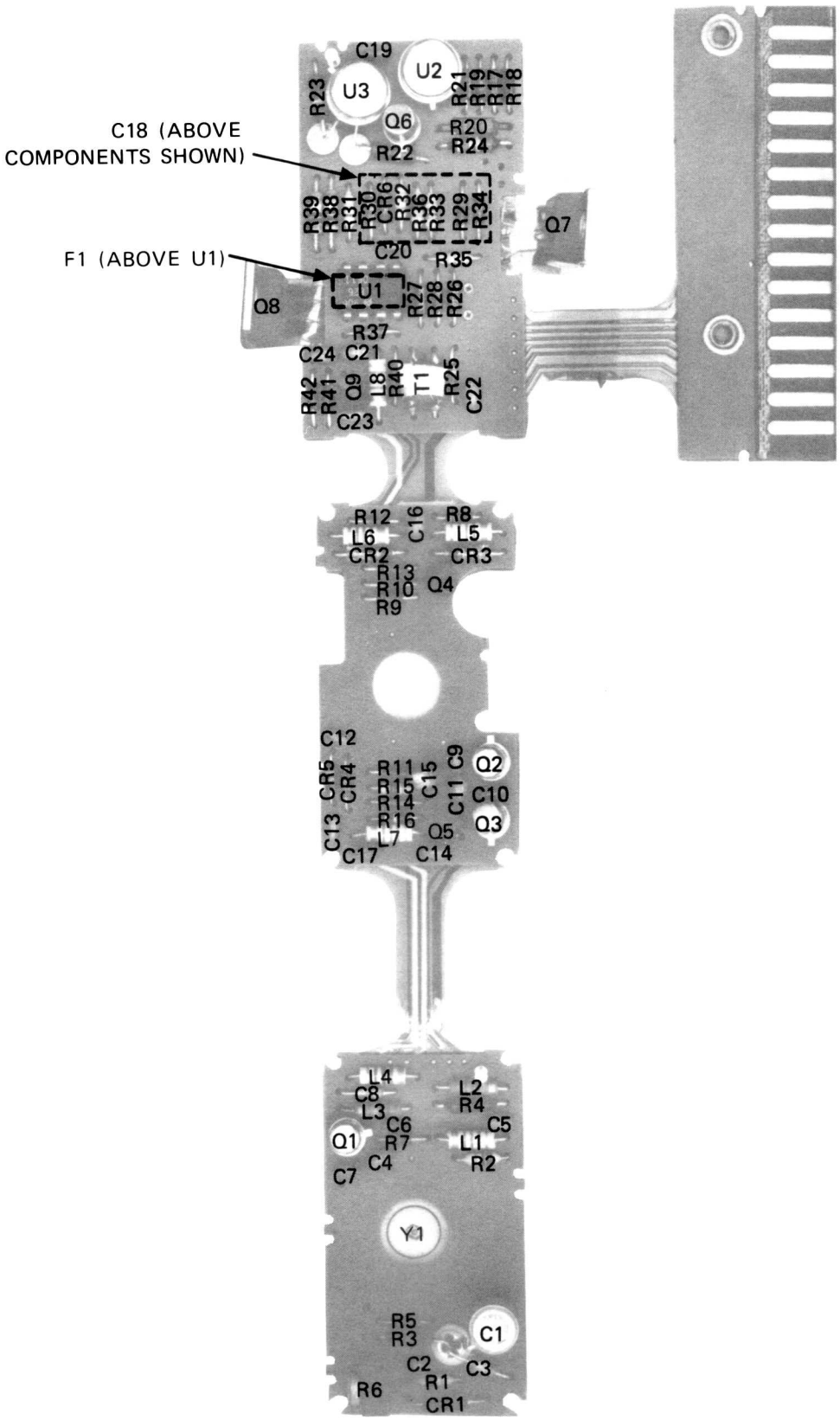
C18 (ABOVE COMPONENTS SHOWN)
F1 (ABOVE U1)
C19
U2
U3
R23
R21
R19
R17
R18
Q6
R20
R22
R24
R39
R38
R31
R30
CR6
R32
R36
R33
R29
R34
Q7
C20
R35
U1
Q8
R27
R28
R26
R37
C24
C21
R42
R41
Q9
L8
R40
T1
R25
C22
C23
R12
L6
CR2
C16
R8
L5
CR3
R13
R10
Q4
R9
C12
CR5
CR4
R11
R15
R14
R16
C15
C9
Q2
C11
C10
Q3
C13
L7
Q5
C17
C14
L4
C8
L3
C6
L2
R4
C5
Q1
R7
L1
C4
R2
C7
Y1
R5
R3
C1
C2
C3
R6
R1
CR1

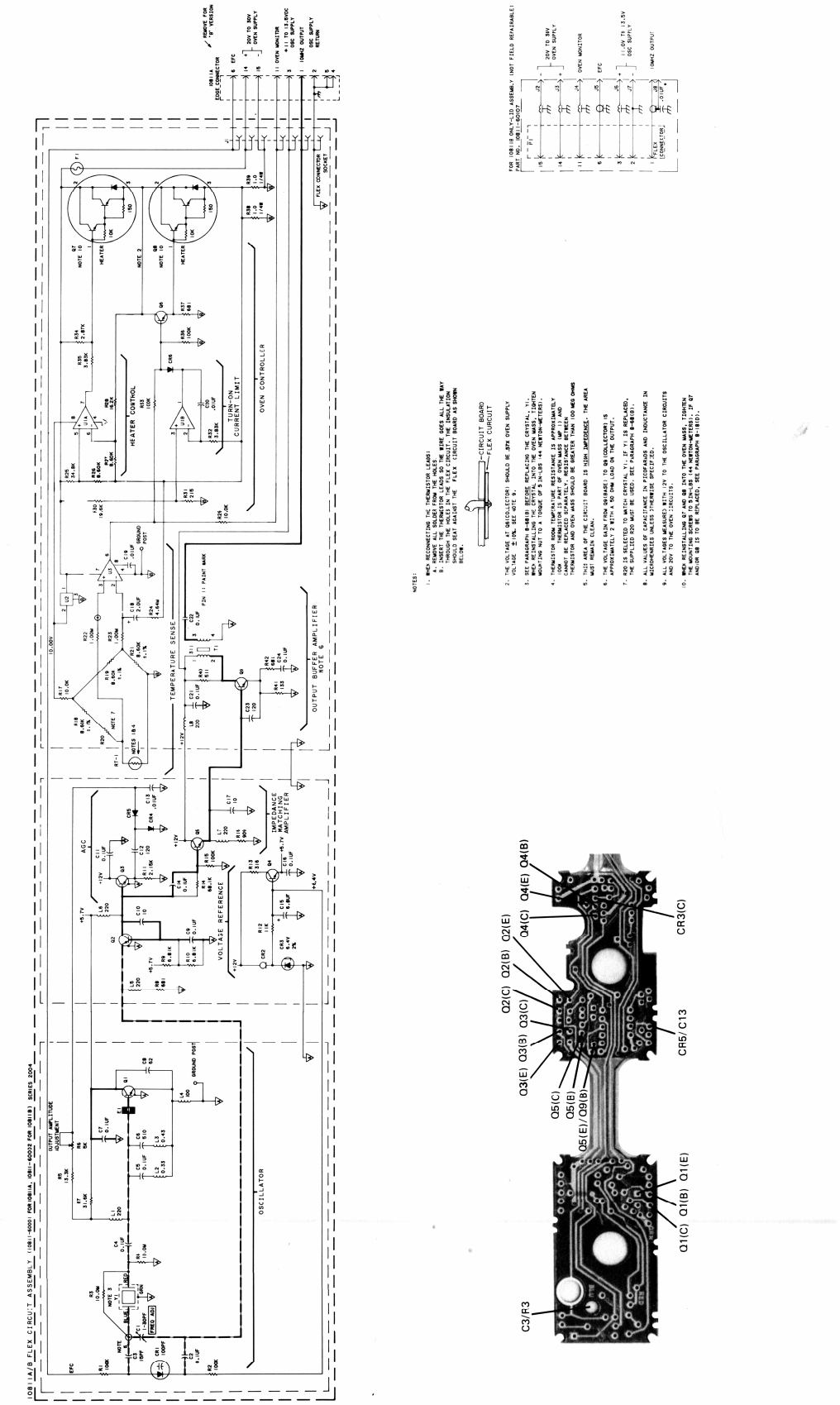


**Figure 8-15. Oven Controller Schematic Diagram**

HEWLETT PACKARD

MANUAL PART NUMBER 10811-90002

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# REVISION PAGE

1. This page records a running history of all changes to this procedure.
2. Rev. A is used to identify the first issue. Subsequent changes to the procedure are identified with letters in the revision column.
3. Description column should include brief before/after details of each change and the page number involved.
4. Every page in this procedure must have, in order, the drawing number, latest revision letter and page # of # located in the page footer.

| Rev. | PCO No. | Page No. Affected | Description of Change | Engineer | Date |
|---|---|---|---|---|---|
| A | | | AS ISSUED | L. Fries | 11-30-90 |
| B | 2-21684 | All | Complete Rewrite | D. Montgomery | 01-20-94 |
| C | 2-22408 | 10,19-22 | Corrected Osc. # on pg.10. Added pages 19-22. | D. Montgomery | 11-27-95 |
| D | 2-22774 | Sections 12,13,14,15 | updated specs. for -60158/60159/60160; added 10811-60164 | D. Montgomery | 10-16-96 |
| E | 2-23023 | 17,25 | Added 10811-60260 | D. Montgomery | 05-01-97 |
| F | 2-23915 | 15 | Updated index. | D. Montgomery | 06-10-99 |
| G | 2-24149 | 15,16 | Updated index. | D. Montgomery | 10-26-99 |
| H | 2-24428 | Section 11 | Add Phase Noise Specs for 10811-60219 | D. Montgomery | 07-17-00 |

Document Owner: PFS Production Manager or Designate

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# Performance Specifications for HP 10811D/E Family Crystal Oscillators

## 1 10811D/E Crystal Oscillators

The performance specifications in section 1 also apply to the following options and subassemblies:

| | |
|---|---|
| 10811-60120 | 10811D Replacement |
| 10811-69120 | 10811D "Blue Stripe" Replacement |
| 10811-60126 | 10811E Replacement |
| 10811-69126 | 10811E "Blue Stripe" Replacement |
| 10811E Option H40 | |
| 10811-60132 | 10811E Option H40 Replacement |
| 10811-69132 | 10811E Option H40 "Blue Stripe" Replacement |

### 1.1 Output Signal

1.1.1 Frequency: 10.000000 MHz.

1.1.2 Voltage: .55V ± .05V rms into 50 Ω

1.1.3 Harmonic Distortion: < -25 dBc.

1.1.4 Spurious Phase Modulation: < -100 dBc (discrete sidebands 10 Hz to 25 kHz).

### 1.2 Frequency Adjustment

1.2.1 Coarse Tuning Range: > ± $1x10^{-6}$ (± 10 Hz).

1.2.2 Electronic Frequency Control (EFC): ≥ $1x10^{-7}$ (1 Hz) total for control. range of -5V to +5V

### 1.3 Frequency Stability

1.3.1 Long Term Stability (Aging Rate):

Aging rate (long term frequency stability is defined as the absolute value (magnitude) of the fractional frequency change with time. An observation time sufficiently long to reduce the effects of random noise to an insignificant value is implied. Frequency changes due to environmental effects must be considered separately.

1.3.1.1 < $5 \times 10^{-10}$ / day after 24 hour warm up when:

1.3.1.1.1 oscillator off time was less than 24 hours and

1.3.1.1.2 oscillator aging rate was < $5 \times 10^{-10}$ / day prior to turn off.

1.3.1.2 < $5 \times 10^{-10}$ / day in less than 30 days of continous operation for off time of greater than 24 hours.

1.3.1.3 < $1 \times 10^{-7}$ / year for continous operation (Typical $1 \times 10^{-8}$ / year after 1 year)

## 1.4 Time Domain Stability

Time domain stability ( $\sigma_y(\tau)$ ) is defined as the two sample deviation of fractional fluctuations due to random noise in the oscillator. The measurement bandwidth is 100 kHz. See NBS Monograph 140 for measurement details.

| Averaging Time (seconds) $\tau$ | Stability $\sigma_y(\tau)$ |
|---|---|
| .001 | < $1.5 \times 10^{-10}$ |
| .01 | < $1.5 \times 10^{-11}$ |
| .1 | < $5.0 \times 10^{-12}$ |
| 1 | < $5.0 \times 10^{-12}$ |
| 10 | < $5.0 \times 10^{-12}$ |
| 100 | < $1.0 \times 10^{-11}$ |
| (Typical)1000 | < $1.0 \times 10^{-11}$ |

## 1.5 Frequency Domain Stability (Phase Noise)

Frequency domain stability is defined as the single sideband noise to signal ratio per Hertz of bandwidth (a power spectral density). This ratio is analogous to a sprectrum analyzer display of the carrier versus either phase modulation sideband. See NBS Monograph 140 for measurement details.

| Offset from Signal (Hz) | Phase Noise (dBc) |
|---|---|
| 1 | < -100 |
| 10 | < -130 |
| 100 | < -150 |
| 1000 | < -157 |
| 10000 | < -160 |

## 1.6 Warm Up

1.6.1 $< 5 \times 10^{-9}$ of final value 10 minutes after turn on when:

1.6.1.1 oscillator is operated in a 25° C environment with 20 Vdc oven supply voltage,

1.6.1.2 oscillator off time was less than 24 hours,

1.6.1.3 oscillator aging rate was $< 5 \times 10^{-10}$ / day prior to turn off..

1.6.1.4 Final value is defined as oscillator frequency 24 hours after turn on.

## 1.7 Environmental Sensitivity

1.7.1 Temperature

1.7.1.1 Frequency Change: $< 4.5 \times 10^{-9}$ from 0° C to +71°C.

1.7.1.2 Operating Range: 0° C to +71°C.

1.7.1.3 Storage Range: -55° C to +85°C.

1.7.2 Load: $< 5 \times 10^{-10}$ for $\pm$ 10% change in 50 $\Omega$ load on output.

1.7.3 Power Supply

1.7.3.1 Oscillator Supply: $< 2 \times 10^{-10}$ for 1% change.

1.7.3.2 Oven Supply: $< 2.5 \times 10^{-10}$ ($< 1 \times 10^{-10}$ typical) for 10% change.

1.7.4 Gravitational Field: $< 4 \times 10^{-9}$ for 2g static shift (180° change in position).

1.7.5 Magnetic Field: Sidebands < -90 dBc for .1 mTesla (1 Gauss) field at 100 Hz

1.7.6 Humidity (typical): $< 1 \times 10^{-9}$ for 95% relative humidity at 40° C.

1.7.7 Shock (survival): 30 g, 11 ms, 1/2 sinwave.

1.7.8 Altitude (typical): $< 2 \times 10^{-9}$ for 0 to 50,000 ft.

## 1.8 Power Requirements

1.8.1 Oscillator Circuit:

1.8.1.1 11.0 to 13.5 Vdc.

1.8.1.2 30 mA typical, 40 mA.

1.8.1.3 < 100 μV ripple and noise

1.8.2 Oven Circuit:

1.8.2.1 20 to 30 Vdc

1.8.2.2 480 mA at 20 V to 720 mA at 30V max.( turn on load is constant and 42 Ω minimum)

1.8.2.3 Steady state power drops to approximately 2 W at 25° C in still air at 20 V.

# 2 10811D/E Option 001

The performance specifications in section 2 also apply to the following subassemblies:

| | |
|---|---|
| 10811-60121 | 10811D Option 001 Replacement |
| 10811-60127 | 10811E Option 001 Replacement |

The performance specifications for the 10811D/E Option 001 are the same as the 10811D/E with the following exceptions:

## 2.1 Aging Rate:

Aging rate (long term frequency stability is defined as the absolute value (magnitude) of the fractional frequency change with time. An observation time sufficiently long to reduce the effects of random noise to an insignificant value is implied. Frequency changes due to environmental effects must be considered separately.

2.1.0.1 $< 1 \times 10^{-10}$ / day after 24 hour warm up when:

2.1.0.1.1 oscillator off time was less than 24 hours and

2.1.0.1.2 oscillator aging rate was $< 1 \times 10^{-10}$ / day prior to turn off.

2.1.0.2 $< 1 \times 10^{-10}$ / day in less than 30 days of continous operation for off time of greater than 24 hours.

2.1.1 $< 3.6 \times 10^{-7}$ / year for continous operation.

# 3 10811D/E Option 002

The performance specifications in section 3 also apply to the following subassemblies:

| | |
|---|---|
| 10811-60122 | 10811D Option 002 Replacement |
| 10811-60128 | 10811E Option 002 Replacement |

The performance specifications for the 10811D/E Option 002 are the same as the 10811D/E with the following exceptions:

## 3.1 Frequency Domain Stability (Phase Noise)

Frequency domain stability is defined as the single sideband noise to signal ratio per Hertz of bandwidth (a power spectral density). This ratio is analogous to a sprectrum analyzer display of the carrier versus either phase modulation sideband. See NBS Monograph 140 for measurement details

.

| Offset from Signal (Hz) | Phase Noise (dBc) |
|---|---|
| 1 | < -103 |
| 10 | < -133 |
| 100 | < -153 |
| 1000 | < -162 |
| 10000 | < -162 |

# 4 10811D/E Option 003

The performance specifications in section 4 also apply to the following subassemblies

| | |
|---|---|
| 10811-60123 | 10811D Option 003 Replacement |
| 10811-60129 | 10811E Option 003 Replacement |

The performance specifications for the 10811D/E Option 003 are the same as the 10811D/E with the following exceptions:

## 4.1 Aging Rate:

Aging rate (long term frequency stability is defined as the absolute value (magnitude) of the fractional frequency change with time. An observation time sufficiently long to reduce the effects of random noise to an insignificant value is implied. Frequency changes due to environmental effects must be considered separately.

4.1.0.1 $< 1 \times 10^{-10}$ / day after 24 hour warm up when:

4.1.0.1.1 oscillator off time was less than 24 hours and

4.1.0.1.2 oscillator aging rate was $< 1 \times 10^{-10}$ / day prior to turn off.

4.1.0.2 $< 1 \times 10^{-10}$ / day in less than 30 days of continous operation for off time of greater than 24 hours.

4.1.0.3 $< 3.6 \times 10^{-7}$ / year for continous operation.

## 4.2 Frequency Domain Stability (Phase Noise)

Frequency domain stability is defined as the single sideband noise to signal ratio per Hertz of bandwidth (a power spectral density). This ratio is analogous to a sprectrum analyzer display of the carrier versus either phase modulation sideband. See NBS Monograph 140 for measurement details

| Offset from Signal (Hz) | Phase Noise (dBc) |
|---|---|
| 1 | < -103 |
| 10 | < -133 |
| 100 | < -153 |
| 1000 | < -162 |
| 10000 | < -162 |

# 5 10811D/E Option 100

The performance specifications in section 5 also apply to the following subassemblies:

| | |
|---|---|
| 10811-60125 | 10811D Option 100 Replacement |
| 10811-60131 | 10811E Option 100 Replacement |
| 10811E Option H41 | |
| 10811-60133 | 10811E Option H41 Replacement |
| 10811-69133 | 10811E Option H41 "Blue Stripe" Replacement |

The performance specifications for the 10811D/E Option H41 are the same as the 10811D/E with the following exceptions

## 5.1 Frequency Adjustment

5.1.1 Coarse Tuning Range: > $\pm$ 8 x $10^{-7}$ ($\pm$ 8 Hz).

5.1.2 Electronic Frequency Control (EFC): Not Specified

## 5.2 Frequency Stability

5.2.1 Long Term Stability (Aging Rate):

Aging rate (long term frequency stability is defined as the absolute value (magnitude) of the fractional frequency change with time. An observation time sufficiently long to reduce the effects of random noise to an insignificant value is implied. Frequency changes due to environmental effects must be considered separately.

5.2.1.1 < 1.5 x $10^{-9}$ / day after 24 hour warm up when:

5.2.1.1.1 oscillator off time was less than 24 hours and

5.2.1.1.2 oscillator aging rate was < 1.5 x $10^{-9}$ / day prior to turn off.

5.2.1.2 < 1.5 x $10^{-9}$ / day in less than 30 days of continous operation for off time of greater than 24 hours.

5.2.1.3 < 5.5 x $10^{-7}$ / year for continous operation.

## 5.3 Time Domain Stability

Time domain stability ( $\sigma_y(\tau)$ ) is defined as the two sample deviation of fractional fluctuations due to random noise in the oscillator. The measurement bandwidth is 100 kHz. See NBS Monograph 140 for measurement details
.

| Averaging Time (seconds) $\tau$ | Stability $\sigma_y(\tau)$ |
|---|---|
| .001 | Not Specified |
| .01 | Not Specified |
| .1 | Not Specified |
| 1 | $< 1.0 \times 10^{-11}$ |
| 10 | Not Specified |
| 100 | Not Specified |
| 1,000 | Not Specified |

## 5.4 Frequency Domain Stability (Phase Noise)

Frequency domain stability is defined as the single sideband noise to signal ratio per Hertz of bandwidth (a power spectral density). This ratio is analogous to a sprectrum analyzer display of the carrier versus either phase modulation sideband. See NBS Monograph 140 for measurement details.

| Offset from Signal (Hz) | Phase Noise (dBc) |
|---|---|
| 1 | Not Specified |
| 10 | Not Specified |
| 100 | Not Specified |
| 1000 | < -155 |
| 10000 | Not Specified |

## 5.5 Warm Up

5.5.1 $< 6 \times 10^{-9}$ of final value 10 minutes after turn on when:

5.5.1.1 oscillator is operated in a 25° C environment with 20 Vdc oven supply voltage,

5.5.1.2 oscillator off time was less than 24 hours,

5.5.1.3 oscillator aging rate was $< 1.5 \times 10^{-9}$ / day prior to turn off.

5.5.1.4 Final value is defined as oscillator frequency 24 hours after turn on.

## 5.6 Temperature

5.6.1 Frequency Change: $< 7 \times 10^{-9}$ from 0° C to +71°C.

### 5.7 Power Supply

5.7.1 Oscillator Supply: < $1 \times 10^{-8}$ for 1% change.

5.7.2 Oven Supply: < $1 \times 10^{-9}$ for 10% change.

### 5.8 Gravitational Field

Not Specified

### 5.9 Magnetic Field

Not Specfied

# 6 10811-60111

The performance specifications in section 6 also apply to the following subassemblies:

| | |
|---|---|
| 10811-69001 | 10811-60111 "Blue Stripe" Replacement |

The performance specifications for the 10811-60111 are the same as the 10811D/E with the following exceptions:

## 6.1 Time Domain Stability

Time domain stability ( $\sigma_y(\tau)$ ) is defined as the two sample deviation of fractional fluctuations due to random noise in the oscillator. The measurement bandwidth is 100 kHz. See NBS Monograph 140 for measurement details.

| Averaging Time (seconds) $\tau$ | Stability $\sigma_y(\tau)$ |
|---|---|
| .001 | Not Specified |
| .01 | Not Specified |
| .1 | Not Specified |
| 1 | $< 1.0 \times 10^{-11}$ |
| 10 | Not Specified |
| 100 | Not Specified |
| 1,000 | Not Specified |

## 6.2 Frequency Domain Stability (Phase Noise)

Not Specified.

## 6.3 Gravitational Field

Not Specified

## 6.4 Magnetic Field

Not Specified

# 7 10811-60109

The performance specifications for the 10811-60109 are the same as the 10811D/E with the following exceptions:

## 7.1 Time Domain Stability

Time domain stability ( $\sigma_y(\tau)$ ) is defined as the two sample deviation of fractional fluctuations due to random noise in the oscillator. The measurement bandwidth is 100 kHz. See NBS Monograph 140 for measurement details.

| Averaging Time (seconds) $\tau$ | Stability $\sigma_y(\tau)$ |
|---|---|
| .001 | $< 1.5 \times 10^{-10}$ |
| .01 | $< 1.5 \times 10^{-11}$ |
| .1 | $< 5.0 \times 10^{-12}$ |
| 1 | $< 2.5 \times 10^{-12}$ |
| 10 | $< 5.0 \times 10^{-12}$ |
| 100 | $< 1.0 \times 10^{-11}$ |
| 1,000 | $< 1.0 \times 10^{-11}$ |

## 7.2 Frequency Domain Stability (Phase Noise)

Frequency domain stability is defined as the single sideband noise to signal ratio per Hertz of bandwidth (a power spectral density). This ratio is analogous to a sprectrum analyzer display of the carrier versus either phase modulation sideband. See NBS Monograph 140 for measurement details

.

| Offset from Signal (Hz) | Phase Noise (dBc) |
|---|---|
| 1 | < -95 |
| 10 | < -120 |
| 100 | < -140 |
| 1000 | < -157 |
| 10000 | < -160 |

# 8 10811-60209

The performance specifications for the 10811-60209 are the same as the 10811D/E with the following exceptions:

## 8.1 Time Domain Stability

Time domain stability ( $\sigma_y(\tau)$ ) is defined as the two sample deviation of fractional fluctuations due to random noise in the oscillator. The measurement bandwidth is 100 kHz. See NBS Monograph 140 for measurement details.

| Averaging Time (seconds) $\tau$ | Stability $\sigma_y(\tau)$ |
|---|---|
| .001 | Not Specified |
| .01 | Not Specified |
| .1 | Not Specified |
| 1 | $< 1.0 \times 10^{-11}$ |
| 10 | Not Specified |
| 100 | Not Specified |
| 1,000 | Not Specified |

## 8.2 Frequency Domain Stability (Phase Noise)

Frequency domain stability is defined as the single sideband noise to signal ratio per Hertz of bandwidth (a power spectral density). This ratio is analogous to a sprectrum analyzer display of the carrier versus either phase modulation sideband. See NBS Monograph 140 for measurement details.

| Offset from Signal (Hz) | Phase Noise (dBc) |
|---|---|
| 1 | < -103 |
| 10 | < -133 |
| 100 | < -153 |
| 1000 | < -162 |
| 10000 | < -162 |

### 8.3 Temperature

8.3.1 Frequency Change: $\leq 7.0 \times 10^{-9}$ from 0° C to +71°C.

### 8.4 Gravitational Field

8.4.1 Not Specified

### 8.5 Magnetic Field

8.5.1 Not Specified

# 9 10811-60211

The performance specifications in section 9 also apply to the following subassemblies:

| | |
|---|---|
| 10811-60260 | 10811-60160 with improved aging |

The performance specifications for the 10811-60211 are the same as the 10811D/E with the following exceptions:

## 9.1 Time Domain Stability

Time domain stability ( $\sigma_y(\tau)$ ) is defined as the two sample deviation of fractional fluctuations due to random noise in the oscillator. The measurement bandwidth is 100 kHz. See NBS Monograph 140 for measurement details

| Averaging Time (seconds) $\tau$ | Stability $\sigma_y(\tau)$ |
|---|---|
| .001 | Not Specified |
| .01 | Not Specified |
| .1 | Not Specified |
| 1 | $< 1.0 \times 10^{-11}$ |
| 10 | Not Specified |
| 100 | Not Specified |
| 1,000 | Not Specified |

## 9.2 Frequency Domain Stability (Phase Noise)

9.2.1 Not Specified

## 9.3 Aging Rate:

Aging rate (long term frequency stability is defined as the absolute value (magnitude) of the fractional frequency change with time. An observation time sufficiently long to reduce the effects of random noise to an insignificant value is implied. Frequency changes due to environmental effects must be considered separately.

9.3.0.1 $< 1 \times 10^{-10}$ / day after 24 hour warm up when:

9.3.0.1.1 oscillator off time was less than 24 hours and

9.3.0.1.2 oscillator aging rate was $< 1 \times 10^{-10}$ / day prior to turn off.

9.3.0.2 $< 1 \times 10^{-10}$ / day in less than 30 days of continous operation for off time of greater than 24 hours.

9.3.0.3 $< 3.6 \times 10^{-7}$ / year for continous operation.

# 10 10811-60102

The performance specifications for the 10811-60102 are the same as the 10811D/E with the following exceptions:

## 10.1 Temperature

10.1.1 Frequency Change: $< 7.0 \times 10^{-9}$ from 0° C to +71°C

# 11 05071-60219

The performance specifications in section 11 also apply to the following options and subassemblies:

| | |
|---|---|
| 05071-69219 | 05071-60219 "Blue Stripe" Replacement |

The performance specifications for the 05071-60219 are the same as the 10811D/E with the following exceptions:

## 11.1 Frequency Adjustment

11.1.1 Coarse Tuning Range: > ± $5 \times 10^{-7}$ (± 5 Hz).

11.1.2 Electronic Frequency Control (EFC): [3] ± $2.5 \times 10^{-7}$ (± 2.5 Hz) for control. range of -5V to +5V

## 11.2 Time Domain Stability

Time domain stability ( $s_y$ (t) ) is defined as the two sample deviation of fractional fluctuations due to random noise in the oscillator. The measurement bandwidth is 100 kHz. See NBS Monograph 140 for measurement details.

| Averaging Time (seconds) t | Stability $s_y$ (t) |
|---|---|
| .001 | < $1.5 \times 10^{-10}$ |
| .01 | < $1.5 \times 10^{-11}$ |
| .1 | < $4.5 \times 10^{-12}$ |
| 1 | < $2.5 \times 10^{-12}$ |
| 10 | < $5.0 \times 10^{-12}$ |
| 100 | < $1.0 \times 10^{-11}$ |
| (Typical)1000 | < $1.0 \times 10^{-11}$ |

## 11.3 Frequency Domain Stability (Phase Noise)

Frequency domain stability is defined as the single sideband noise to signal ratio per Hertz of bandwidth (a power spectral density). This ratio is analogous to a sprectrum analyzer display of the carrier versus either phase modulation sideband. See NBS Monograph 140 for measurement details.

| Offset from Signal (Hz) | Phase Noise (dBc) |
|---|---|
| 1 | < -100 |
| 10 | < -137 |
| 100 | < -150 |
| 1000 | < -155 |
| 10000 | < -155 |

# 12 10811-60158

The performance specifications in section 12 also apply to the following options and subassemblies:

| | |
|---|---|
| 10811-60159 | 10811-60158 with shock mount studs |
| | |

The performance specifications for the 10811-60158/60159 are the same as the 10811D/E with the following exceptions:

## 12.1 Frequency Adjustment

12.1.1 Coarse Tuning Range: > ± $5x10^{-7}$ (± 5 Hz).

12.1.2 Electronic Frequency Control (EFC): > ± $2.0x10^{-7}$ (± 2.5 Hz) for control. range of -5V to +5V

## 12.2 Frequency Stability

12.2.1 Long Term Stability (Aging Rate):

Aging rate (long term frequency stability is defined as the absolute value (magnitude) of the fractional frequency change with time. An observation time sufficiently long to reduce the effects of random noise to an insignificant value is implied. Frequency changes due to environmental effects must be considered separately.

12.2.1.1 < $2.5 \times 10^{-10}$ / day after 24 hour warm up when:

12.2.1.1.1 oscillator off time was less than 24 hours and

12.2.1.1.2 oscillator aging rate was <$2.5 \times 10^{-10}$ / day prior to turn off.

12.2.1.2 < $2.5 \times 10^{-10}$ / day in less than 30 days of continous operation for off time of greater than 24 hours.

12.2.1.3 < $1 \times 10^{-7}$ / year for continous operation (Typical $1 \times 10^{-8}$ / year after 1 year)

## 12.3 Time Domain Stability

Time domain stability ( $\sigma_y(\tau)$ ) is defined as the two sample deviation of fractional fluctuations due to random noise in the oscillator. The measurement bandwidth is 100 kHz. See NBS Monograph 140 for measurement details.

| Averaging Time (seconds) $\tau$ | Stability $\sigma_y(\tau)$ |
|---|---|
| .001 | $< 1.5 \times 10^{-10}$ |
| .01 | $< 1.5 \times 10^{-11}$ |
| .1 | $< 5.0 \times 10^{-12}$ |
| 1 | $< 9.8 \times 10^{-13}$ |
| 10 | $< 5.0 \times 10^{-12}$ |
| 100 | $< 1.0 \times 10^{-11}$ |
| (Typical)1000 | $< 1.0 \times 10^{-11}$ |

## 12.4 Frequency Domain Stability (Phase Noise)

Frequency domain stability is defined as the single sideband noise to signal ratio per Hertz of bandwidth (a power spectral density). This ratio is analogous to a sprectrum analyzer display of the carrier versus either phase modulation sideband. See NBS Monograph 140 for measurement details.

| Offset from Signal (Hz) | Phase Noise (dBc) |
|---|---|
| 1 | < -95 |
| 10 | < -125 |
| 100 | < -135 |
| 1000 | < -145 |
| 10000 | < -150 |

## 12.5 Environmental Sensitivity

12.5.1 Gravitational Sensitivity: Not Specified

## 12.6 Power Requirements

12.6.1 Oven Circuit:

12.6.1.1 12 to 30 Vdc

12.6.1.2 11 W max.at turn on

12.6.1.3 Steady state power drops to approximately 2 W at 25° C in still air at 20 V.

# 13 10811-60160

The performance specifications in section 13 also apply to the following options and subassemblies:

| | |
|---|---|
| | |

The performance specifications for the 10811-60160 are the same as the 10811-60111 with the following exceptions:

## 13.1 Frequency Adjustment

13.1.1 Coarse Tuning Range: > ± $5x10^{-7}$ (± 5 Hz).

13.1.2 Electronic Frequency Control (EFC): > ± $2.0x10^{-7}$ (± 2.5 Hz) for control. range of -5V to +5V

## 13.2 Power Requirements

13.2.1 Oven Circuit:

13.2.1.1 12 to 30 Vdc

13.2.1.2 11 W max.at turn on

13.2.1.3 Steady state power drops to approximately 2 W at 25° C in still air at 20 V.

# 14 10811-60164

The performance specifications in section 6 also apply to the following subassemblies:

| | |
|---|---|
| | |

The performance specifications for the 10811-60164 are the same as the 10811D/E with the following exceptions:

## 14.1 Output Signal

14.1.1 Harmonic Distortion: Not Specified

14.1.2 Spurious Phase Modulation: Not Specified

## 14.2 Frequency Adjustment

14.2.1 Coarse Tuning Range: $> \pm 5 \times 10^{-7}$ ($\pm$ 5 Hz).

14.2.2 Electronic Frequency Control (EFC): $> \pm 2.0 \times 10^{-7}$ ($\pm$ 2.5 Hz) for control. range of -5V to +5V

## 14.3 Frequency Stability

14.3.1 Long Term Stability (Aging Rate):

Aging rate (long term frequency stability is defined as the absolute value (magnitude) of the fractional frequency change with time. An observation time sufficiently long to reduce the effects of random noise to an insignificant value is implied. Frequency changes due to environmental effects must be considered separately.

14.3.1.1 $< 1 \times 10^{-8}$ / day

## 14.4 Time Domain Stability

Not Specified

## 14.5 Frequency Domain Stability (Phase Noise)

Not Specified.

## 14.6 Warm Up

Not Specified

## 14.7 Environmental Sensitivity

Not Specified

## 14.8 Power Requirements

14.8.1 Oven Circuit:

14.8.1.1 12 to 30 Vdc

14.8.1.2 11 W max.at turn on

14.8.1.3 Steady state power drops to approximately 2 W at 25° C in still air at 20 V.

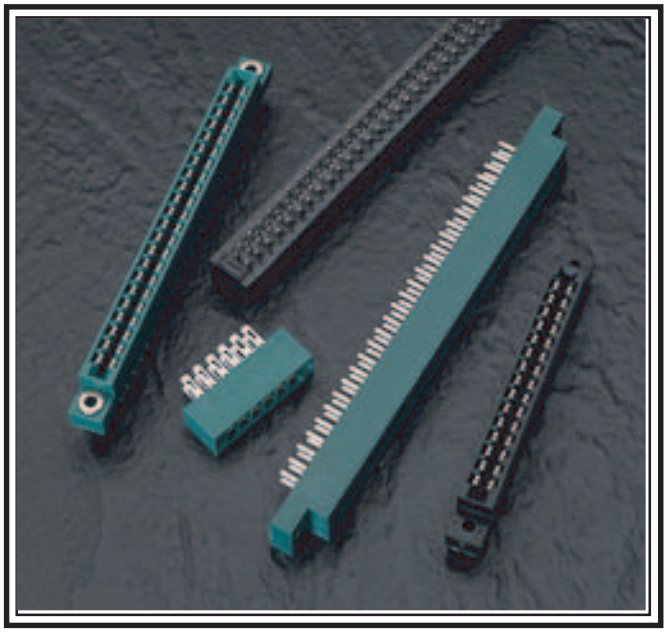
# 15 Index

| Product/Assembly Number | Description | Status | PCO Number | Section Number |
|---|---|---|---|---|
| 05071-60219 | 5071A, SCD only | | | 11 |
| 05071-69219 | 05071-60219 "Blue Stripe" Exchange | | | 11 |
| 10811-60102 | 10811E #H40 & H41 subassembly | Obsolete | 2-24149 | 10 |
| 10811-60109 | 5065A/5061B, SCD only | | | 7 |
| 10811-60111 | Counter products. SCD only | | | 6 |
| 10811-60120 | 10811D Replacement | | | 1 |
| 10811-60121 | 10811D #001 Replacement | Obsolete | 2-23915 | 2 |
| 10811-60122 | 10811D #002 Replacement | Obsolete | 2-23915 | 3 |
| 10811-60123 | 10811D #003 Replacement | Obsolete | 2-23915 | 4 |
| 10811-60125 | 10811D #100 Replacement | Obsolete | 2-21686 | 5 |
| 10811-60126 | 10811E Replacement | | | 1 |
| 10811-60127 | 10811E #001 Replacement | Obsolete | 2-23915 | 2 |
| 10811-60128 | 10811E #002 Replacement | Obsolete | 2-23915 | 3 |
| 10811-60129 | 10811E #003 Replacement | Obsolete | 2-23915 | 4 |
| 10811-60131 | 10811E #100 Replacement | Obsolete | 2-21931 | 5 |
| 10811-60132 | 10811E #H40 Replacement | Obsolete | 2-24149 | 1 |
| 10811-60133 | 10811E #H41 Replacement | Obsolete | 2-22396 | 5 |
| 10811-60152 | 10811D #023 subassembly | Obsolete | 2-21931 | |
| 10811-60153 | 10811E #023 subassembly | Obsolete | 2-21931 | |
| 10811-60154 | Untested 10811E subassembly | | | |
| 10811-60155 | Untested 10811D subassembly | | | |
| 10811-60158 | Sealed osc. with -60005 brd. set | | | 12 |
| 10811-60159 | Sealed osc. with -60005 brd. set/studs | | | 12 |
| 10811-60160 | "D" type osc. with -60005 brd. set | | | 13 |
| 10811-60164 | Osc-159 Rdcd Spec | | 2-22774 | 14 |
| 10811-60209 | Spokane Div Only | Obsolete | 2-21931 | 8 |
| 10811-60211 | Counter products, SCD only | | | 9 |
| 10811-60260 | Improved Aging | | 2-23023 | 9 |
| 10811-69001 | 10811-60111 "Blue Stripe" Exchange | | | 6 |
| 10811-69120 | 10811D "Blue Stripe" Exchange | | | 1 |
| 10811-69126 | 10811E "Blue Stripe" Replacement | | | 1 |
| 10811-69132 | 10811E #H40 "Blue Stripe" Exchange | Obsolete | 2-24149 | 1 |
| 10811-69133 | 10811E #H41 "Blue Stripe" Exchange | Obsolete | 2-22396 | 5 |
| 10811D | | | | 1 |
| 10811D #001 | Improved aging | Obsolete | 2-23915 | 2 |
| 10811D #002 | Improved phase noise | Obsolete | 2-23915 | 3 |

| Product/Assembly Number | Description | Status | PCO Number | Section Number |
|---|---|---|---|---|
| 10811D #003 | Improved aging and phase noise | Obsolete | 2-23915 | 4 |
| 10811D #023 | 10.23 MHz | Obsolete | 2-21677 | |
| 10811D #100 | Reduced Spec | Obsolete | 2-21686 | 5 |
| 10811E | | | | 1 |
| 10811E #001 | Improved aging | Obsolete | 2-23915 | 2 |
| 10811E #002 | Improved phase noise | Obsolete | 2-23915 | 3 |
| 10811E #003 | Improved aging and phase noise | Obsolete | 2-23915 | 4 |
| 10811D #023 | 10.23 MHz | Obsolete | 2-21677 | |
| 10811E #100 | Reduced Spec | Obsolete | 2-21686 | 5 |
| 10811E #H40 | | Obsolete | 2-24149 | 1 |
| 10811E #H41 | | Obsolete | 2-22396 | 5 |

# 305/315/355 SERIES CARD EDGE CONNECTOR

.156" (3.96mm) Contact Spacing



## FEATURES

- 305/355 Series CSA Approved and UL Recognized
- 315 Series UL Recognized
- .156 (3.96) Contact Spacing x .140 (3.56) Row Spacing
- Accepts .062 (1.57) Nominal Thickness P.C. Board
- Low Profile Insulator Body, .460 (11.68)
- Contact Termination Options include P.C. Tail, Wire Hole & Extender Board Bends
- Large Variety of Mounting Options
- Pre-assembled Card Guides Available
- Accepts Between Contact and In-Contact Polarizing Keys

## SPECIFICATIONS

- Insulator Material: Thermoplastic Polyester, UL 94V-0
- Contact Material: Copper, Nickel, Tin Alloy CA-725
- Contact Plating: Gold on the Mating Area, Tin on the Contact Tails, Nickel Underplate
- Current Rating: 5 Amperes Continuous
- Contact Resistance: 10 Milliohms Maximum
- Dielectric Withstanding Voltage: 1800 V AC rms at Sea Level Between Adjacent Contacts
- Insulation Resistance: 5000 Megohms Minimum
- Operating Temperature: -65 to +105 Degrees C
- Insertion Force: 16 oz (4.45 N) Maximum per Contact Pair when Tested with a .070 (1.78) Thick Gauge
- Withdrawal Force: 1 oz (0.28 N) Minimum per Contact Pair when Tested with a .054 (1.37) Thick Gauge

## 305/315/355 SERIES ORDERING CODE

**Example Part Number 305 - 056 - 521 - 2 04**

- **Series**
- **Total Number of Contacts**
- **Contact Code**
- **Insulator Style**
- **Mounting Options**

| Series | Insulator Colour | Card Slot Length |
|---|---|---|
| 305 | Green | Standard Length per MIL-C-21097 |
| 315 | Green | .020 (0.51) Shorter than Standard |
| 355 | Black | Standard Length per MIL-C-21097 |

| Total Number of Contacts [1] | Contact Rows |
|---|---|
| 012, 014,...086 | Dual Row |

| Contact Code [2, 3] | Description & Tail Size | Tail Length "G" |
|---|---|---|
| 500 | Wire Hole.087 x .013 (2.21 x 0.33) | .282 (7.16) |
| 520 | P.C. Tail .046 x .013 (1.17 x 0.33) | .213 (5.41) |
| 521 | P.C. Tail .046 x .013 (1.17 x 0.33) | .125 (3.18) |
| 555 | Extender Board Bend (Code 500 Contacts) | |
| 556 | Extender Board Bend (Code 520 Contacts) | |

| Insulator Style [4] | Description |
|---|---|
| 2 | .295 (7.49) Card Slot Depth |
| 5 | .330 (8.38) Card Slot Depth |

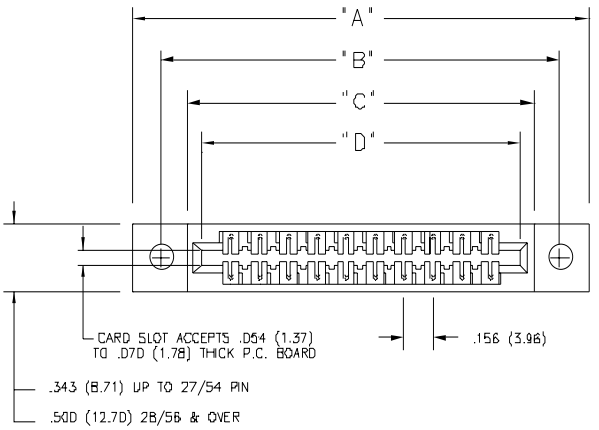
| Mounting Options [5] | Description |
|---|---|
| 01 | No Mounting Lugs |
| 02 | .128 (3.25) Dia. Mounting Holes |
| 03 | .116 (2.95) I.D. Floating Eyelets |
| 04 | .156 (3.96) Dia. Mounting Holes |
| 07 | M3-0.5 Metric Threaded Inserts |
| 08 | #4-40 Unified Threaded Inserts |
| 58 | .468 (11.89) Offset Card Guides |
| 68 | .344 (8.74) Offset Card Guides |
| 78 | In-Line Card Guides |

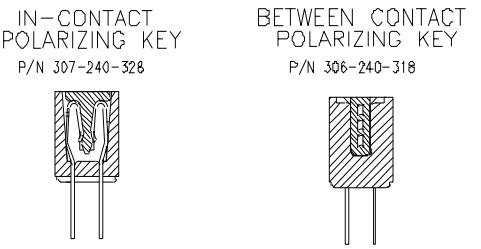
**Ordering Code Notes**

1) All connector sizes up to 86 contacts dual row are available upon request.
2) Consult with Edac regarding single row configuration and wire wrap tail options.
3) For details of the extender board bends, refer to page 66.
4) Insulator style code 5 is available for the 305 and 355 series upon request.
5) For details of the mounting options, refer to page 68.

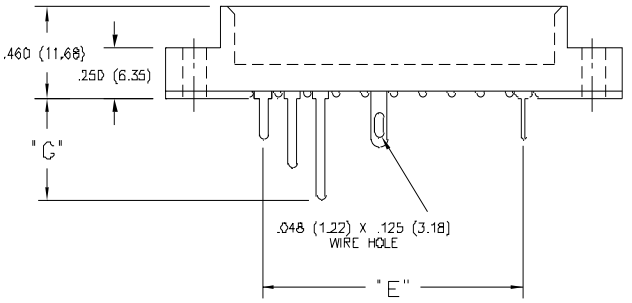


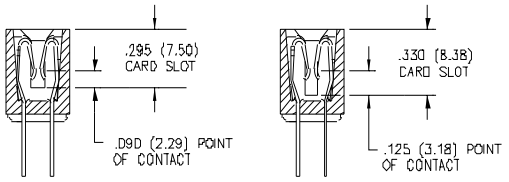
Tel: (416) 754 - 3322



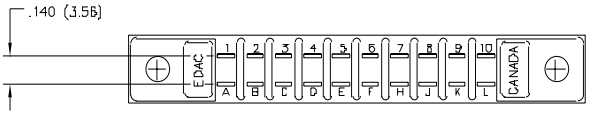

SECTIONS THROUGH CONTACT POSITION

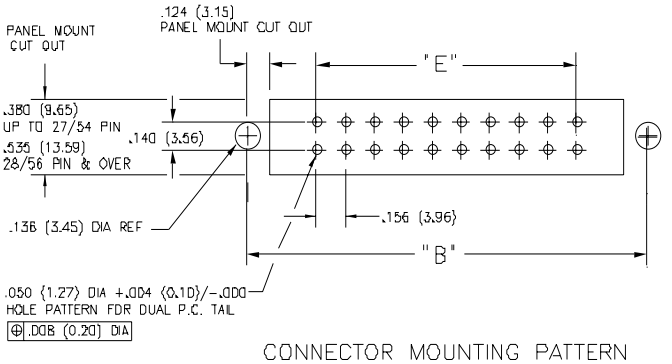


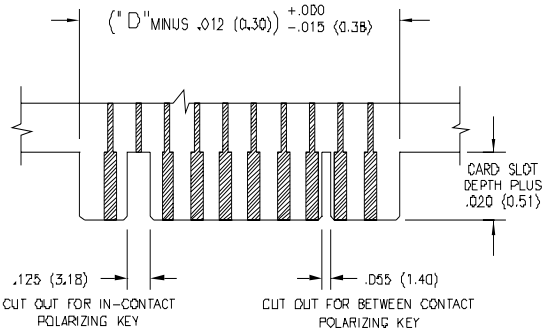

INSULATOR STYLE CODE 2

INSULATOR STYLE CODE 5





.124 (3.15) PANEL MOUNT CUT OUT
PANEL MOUNT CUT OUT
"E"
.380 (9.65) UP TO 27/54 PIN
.535 (13.59) 28/56 PIN & OVER
.140 (3.56)
.136 (3.45) DIA REF
.156 (3.96)
"B"
.050 (1.27) DIA +.004 (0.10)/-.000 HOLE PATTERN FOR DUAL P.C. TAIL
.008 (0.20) DIA

CONNECTOR MOUNTING PATTERN


("D" MINUS .012 (0.30)) +.000 -.015 (0.38)
CARD SLOT DEPTH PLUS .020 (0.51)
.125 (3.18)
CUT OUT FOR IN-CONTACT POLARIZING KEY
.055 (1.40)
CUT OUT FOR BETWEEN CONTACT POLARIZING KEY

RECOMMENDED DAUGHTER BOARD

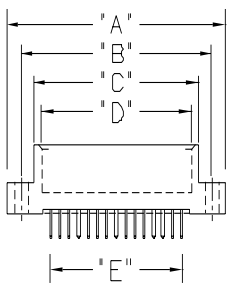
| NUMBER OF CONTACTS | "A" | | "B" | | "C" | | "D" | | | | "E" | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 305, 355 | | 315 | | | |
| Dual | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) |
| 12 | 1.842 | (46.79) | 1.532 | (38.91) | 1.246 | (31.65) | 1.100 | (27.94) | 1.080 | (27.43) | .780 | (19.81) |
| 20 | 2.466 | (62.64) | 2.156 | (54.76) | 1.870 | (47.50) | 1.724 | (43.79) | 1.704 | (43.28) | 1.404 | (35.66) |
| 24 | 2.778 | (70.56) | 2.468 | (62.69) | 2.182 | (55.42) | 2.036 | (51.71) | 2.016 | (51.21) | 1.716 | (43.59) |
| 30 | 3.246 | (82.45) | 2.936 | (74.57) | 2.650 | (67.31) | 2.504 | (63.60) | 2.484 | (63.09) | 2.184 | (55.47) |
| 36 | 3.714 | (94.34) | 3.404 | (86.46) | 3.118 | (79.20) | 2.972 | (75.49) | 2.952 | (74.98) | 2.652 | (67.36) |
| 44 | 4.338 | (110.19) | 4.028 | (102.31) | 3.742 | (95.05) | 3.596 | (91.34) | 3.576 | (90.83) | 3.276 | (83.21) |
| 48 | 4.650 | (118.11) | 4.340 | (110.24) | 4.054 | (102.97) | 3.908 | (99.26) | 3.888 | (98.76) | 3.588 | (91.14) |
| 50 | 4.806 | (122.07) | 4.496 | (114.20) | 4.210 | (106.93) | 4.064 | (103.23) | 4.044 | (102.72) | 3.744 | (95.10) |
| 56 | 5.274 | (133.96) | 4.964 | (126.09) | 4.678 | (118.82) | 4.532 | (115.11) | 4.512 | (114.60) | 4.212 | (106.98) |
| 60 | 5.586 | (141.88) | 5.276 | (134.01) | 4.990 | (126.75) | 4.844 | (123.04) | 4.824 | (122.53) | 4.524 | (114.91) |
| 72 | 6.522 | (165.66) | 6.212 | (157.78) | 5.926 | (150.52) | 5.780 | (146.81) | 5.760 | (146.30) | 5.460 | (138.68) |
| 86 | 7.614 | (193.40) | 7.304 | (185.52) | 7.018 | (178.26) | 6.872 | (174.55) | 6.852 | (174.04) | 6.552 | (166.42) |


Dimensions of Other Connector Sizes are Listed on Page 74

# .156" (3.96mm) CONTACT SPACING CONNECTOR DIMENSIONS

303, 305, 306, 307, 315, 316, 317, 333, 336, 337, 355, 356, 357, 387, 737 Series Card Edge Connectors

| DIMENSION | | "A" | | | | | | | | "B" | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SERIES | | 317 | | 333 | | 336 | | REST OF SERIES | | 317 | | 333, 336 | | REST OF SERIES | |
| Number of Contacts Single | Dual | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) |
| 6 | 12 | 1.830 | (46.48) | 1.784 | (45.31) | 1.857 | (47.17) | 1.842 | (46.79) | 1.539 | (39.09) | 1.534 | (38.96) | 1.532 | (38.91) |
| 7 | 14 | 1.986 | (50.44) | 1.940 | (49.28) | 2.013 | (51.13) | 1.998 | (50.75) | 1.695 | (43.05) | 1.690 | (42.93) | 1.688 | (42.88) |
| 8 | 16 | 2.142 | (54.41) | 2.096 | (53.24) | 2.169 | (55.09) | 2.154 | (54.71) | 1.851 | (47.02) | 1.846 | (46.89) | 1.844 | (46.84) |
| 9 | 18 | 2.298 | (58.37) | 2.252 | (57.20) | 2.325 | (59.06) | 2.310 | (58.67) | 2.007 | (50.98) | 2.002 | (50.85) | 2.000 | (50.80) |
| 10 | 20 | 2.454 | (62.33) | 2.408 | (61.16) | 2.481 | (63.02) | 2.466 | (62.64) | 2.163 | (54.94) | 2.158 | (54.81) | 2.156 | (54.76) |
| 11 | 22 | 2.610 | (66.29) | 2.564 | (65.13) | 2.637 | (66.98) | 2.622 | (66.60) | 2.319 | (58.90) | 2.314 | (58.78) | 2.312 | (58.72) |
| 12 | 24 | 2.766 | (70.26) | 2.720 | (69.09) | 2.793 | (70.94) | 2.778 | (70.56) | 2.475 | (62.87) | 2.470 | (62.74) | 2.468 | (62.69) |
| 13 | 26 | 2.922 | (74.22) | 2.876 | (73.05) | 2.949 | (74.90) | 2.934 | (74.52) | 2.631 | (66.83) | 2.626 | (66.70) | 2.624 | (66.65) |
| 14 | 28 | 3.078 | (78.18) | 3.032 | (77.01) | 3.105 | (78.87) | 3.090 | (78.49) | 2.787 | (70.79) | 2.782 | (70.66) | 2.780 | (70.61) |
| 15 | 30 | 3.234 | (82.14) | 3.188 | (80.98) | 3.261 | (82.83) | 3.246 | (82.45) | 2.943 | (74.75) | 2.938 | (74.63) | 2.936 | (74.57) |
| 16 | 32 | 3.390 | (86.11) | 3.344 | (84.94) | 3.417 | (86.79) | 3.402 | (86.41) | 3.099 | (78.71) | 3.094 | (78.59) | 3.092 | (78.54) |
| 17 | 34 | 3.546 | (90.07) | 3.500 | (88.90) | 3.573 | (90.75) | 3.558 | (90.37) | 3.255 | (82.68) | 3.250 | (82.55) | 3.248 | (82.50) |
| 18 | 36 | 3.702 | (94.03) | 3.656 | (92.86) | 3.729 | (94.72) | 3.714 | (94.34) | 3.411 | (86.64) | 3.406 | (86.51) | 3.404 | (86.46) |
| 19 | 38 | 3.858 | (97.99) | 3.812 | (96.82) | 3.885 | (98.68) | 3.870 | (98.30) | 3.567 | (90.60) | 3.562 | (90.47) | 3.560 | (90.42) |
| 20 | 40 | 4.014 | (101.96) | 3.968 | (100.79) | 4.041 | (102.64) | 4.026 | (102.26) | 3.723 | (94.56) | 3.718 | (94.44) | 3.716 | (94.39) |
| 21 | 42 | 4.170 | (105.92) | 4.124 | (104.75) | 4.197 | (106.60) | 4.182 | (106.22) | 3.879 | (98.53) | 3.874 | (98.40) | 3.872 | (98.35) |
| 22 | 44 | 4.326 | (109.88) | 4.280 | (108.71) | 4.353 | (110.57) | 4.338 | (110.19) | 4.035 | (102.49) | 4.030 | (102.36) | 4.028 | (102.31) |
| 23 | 46 | 4.482 | (113.84) | 4.436 | (112.67) | 4.509 | (114.53) | 4.494 | (114.15) | 4.191 | (106.45) | 4.186 | (106.32) | 4.184 | (106.27) |
| 24 | 48 | 4.638 | (117.81) | 4.592 | (116.64) | 4.665 | (118.49) | 4.650 | (118.11) | 4.347 | (110.41) | 4.342 | (110.29) | 4.340 | (110.24) |
| 25 | 50 | 4.794 | (121.77) | 4.748 | (120.60) | 4.821 | (122.45) | 4.806 | (122.07) | 4.503 | (114.38) | 4.498 | (114.25) | 4.496 | (114.20) |
| 26 | 52 | 4.950 | (125.73) | 4.904 | (124.56) | 4.977 | (126.42) | 4.962 | (126.03) | 4.659 | (118.34) | 4.654 | (118.21) | 4.652 | (118.16) |
| 27 | 54 | 5.106 | (129.69) | 5.060 | (128.52) | 5.133 | (130.38) | 5.118 | (130.00) | 4.815 | (122.30) | 4.810 | (122.17) | 4.808 | (122.12) |
| 28 | 56 | 5.262 | (133.65) | 5.216 | (132.49) | 5.289 | (134.34) | 5.274 | (133.96) | 4.971 | (126.26) | 4.966 | (126.14) | 4.964 | (126.09) |
| 29 | 58 | 5.418 | (137.62) | 5.372 | (136.45) | 5.445 | (138.30) | 5.430 | (137.92) | 5.127 | (130.23) | 5.122 | (130.10) | 5.120 | (130.05) |
| 30 | 60 | 5.574 | (141.58) | 5.528 | (140.41) | 5.601 | (142.27) | 5.586 | (141.88) | 5.283 | (134.19) | 5.278 | (134.06) | 5.276 | (134.01) |
| 31 | 62 | 5.730 | (145.54) | 5.684 | (144.37) | 5.757 | (146.23) | 5.742 | (145.85) | 5.439 | (138.15) | 5.434 | (138.02) | 5.432 | (137.97) |
| 32 | 64 | 5.886 | (149.50) | 5.840 | (148.34) | 5.913 | (150.19) | 5.898 | (149.81) | 5.595 | (142.11) | 5.590 | (141.99) | 5.588 | (141.94) |
| 33 | 66 | 6.042 | (153.47) | 5.996 | (152.30) | 6.069 | (154.15) | 6.054 | (153.77) | 5.751 | (146.08) | 5.746 | (145.95) | 5.744 | (145.90) |
| 34 | 68 | 6.198 | (157.43) | 6.152 | (156.26) | 6.225 | (158.12) | 6.210 | (157.73) | 5.907 | (150.04) | 5.902 | (149.91) | 5.900 | (149.86) |
| 35 | 70 | 6.354 | (161.39) | 6.308 | (160.22) | 6.381 | (162.08) | 6.366 | (161.70) | 6.063 | (154.00) | 6.058 | (153.87) | 6.056 | (153.82) |
| 36 | 72 | 6.510 | (165.35) | 6.464 | (164.19) | 6.537 | (166.04) | 6.522 | (165.66) | 6.219 | (157.96) | 6.214 | (157.84) | 6.212 | (157.78) |
| 37 | 74 | 6.666 | (169.32) | 6.620 | (168.15) | 6.693 | (170.00) | 6.678 | (169.62) | 6.375 | (161.93) | 6.370 | (161.80) | 6.368 | (161.75) |
| 38 | 76 | 6.822 | (173.28) | 6.776 | (172.11) | 6.849 | (173.96) | 6.834 | (173.58) | 6.531 | (165.89) | 6.526 | (165.76) | 6.524 | (165.71) |
| 39 | 78 | 6.978 | (177.24) | 6.932 | (176.07) | 7.005 | (177.93) | 6.990 | (177.55) | 6.687 | (169.85) | 6.682 | (169.72) | 6.680 | (169.67) |
| 40 | 80 | 7.134 | (181.20) | 7.088 | (180.04) | 7.161 | (181.89) | 7.146 | (181.51) | 6.843 | (173.81) | 6.838 | (173.69) | 6.836 | (173.63) |
| 41 | 82 | 7.290 | (185.17) | 7.244 | (184.00) | 7.317 | (185.85) | 7.302 | (185.47) | 6.999 | (177.77) | 6.994 | (177.65) | 6.992 | (177.60) |
| 42 | 84 | 7.446 | (189.13) | 7.400 | (187.96) | 7.473 | (189.81) | 7.458 | (189.43) | 7.155 | (181.74) | 7.150 | (181.61) | 7.148 | (181.56) |
| 43 | 86 | 7.602 | (193.09) | 7.556 | (191.92) | 7.629 | (193.78) | 7.614 | (193.40) | 7.311 | (185.70) | 7.306 | (185.57) | 7.304 | (185.52) |
| 44 | 88 | | | | | | | 7.770 | (197.36) | | | | | 7.460 | (189.48) |



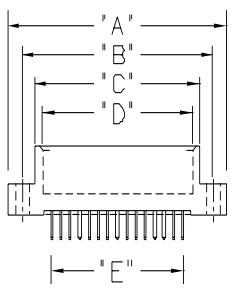



Tel: (416) 754 - 3322

# CONNECTOR DIMENSIONS CONTACT SPACING .156" (3.96mm)

Card Edge Connector Series 303, 305, 306, 307, 315, 316, 317, 333, 336, 337, 355, 356, 357, 387, 737

| DIMENSION | | "C" | | | | | | | | "D" | | | | "E" | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SERIES | | 303, 317 | | 333 | | 336 | | REST OF SERIES | | 315, 316 | | REST OF SERIES | | ALL SERIES | |
| Number of Contacts Single | Dual | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) | Inch | (mm) |
| 6 | 12 | 1.220 | (30.99) | 1.261 | (32.03) | 1.216 | (30.89) | 1.246 | (31.65) | 1.080 | (27.43) | 1.100 | (27.94) | .780 | (19.81) |
| 7 | 14 | 1.376 | (34.95) | 1.417 | (35.99) | 1.372 | (34.85) | 1.402 | (35.61) | 1.236 | (31.39) | 1.256 | (31.90) | .936 | (23.77) |
| 8 | 16 | 1.532 | (38.91) | 1.573 | (39.95) | 1.528 | (38.81) | 1.558 | (39.57) | 1.392 | (35.36) | 1.412 | (35.86) | 1.092 | (27.74) |
| 9 | 18 | 1.688 | (42.88) | 1.729 | (43.92) | 1.684 | (42.77) | 1.714 | (43.54) | 1.548 | (39.32) | 1.568 | (39.83) | 1.248 | (31.70) |
| 10 | 20 | 1.844 | (46.84) | 1.885 | (47.88) | 1.840 | (46.74) | 1.870 | (47.50) | 1.704 | (43.28) | 1.724 | (43.79) | 1.404 | (35.66) |
| 11 | 22 | 2.000 | (50.80) | 2.041 | (51.84) | 1.996 | (50.70) | 2.026 | (51.46) | 1.860 | (47.24) | 1.880 | (47.75) | 1.560 | (39.62) |
| 12 | 24 | 2.156 | (54.76) | 2.197 | (55.80) | 2.152 | (54.66) | 2.182 | (55.42) | 2.016 | (51.21) | 2.036 | (51.71) | 1.716 | (43.59) |
| 13 | 26 | 2.312 | (58.72) | 2.353 | (59.77) | 2.308 | (58.62) | 2.338 | (59.39) | 2.172 | (55.17) | 2.192 | (55.68) | 1.872 | (47.55) |
| 14 | 28 | 2.468 | (62.69) | 2.509 | (63.73) | 2.464 | (62.59) | 2.494 | (63.35) | 2.328 | (59.13) | 2.348 | (59.64) | 2.028 | (51.51) |
| 15 | 30 | 2.624 | (66.65) | 2.665 | (67.69) | 2.620 | (66.55) | 2.650 | (67.31) | 2.484 | (63.09) | 2.504 | (63.60) | 2.184 | (55.47) |
| 16 | 32 | 2.780 | (70.61) | 2.821 | (71.65) | 2.776 | (70.51) | 2.806 | (71.27) | 2.640 | (67.06) | 2.660 | (67.56) | 2.340 | (59.44) |
| 17 | 34 | 2.936 | (74.57) | 2.977 | (75.62) | 2.932 | (74.47) | 2.962 | (75.23) | 2.796 | (71.02) | 2.816 | (71.53) | 2.496 | (63.40) |
| 18 | 36 | 3.092 | (78.54) | 3.133 | (79.58) | 3.088 | (78.44) | 3.118 | (79.20) | 2.952 | (74.98) | 2.972 | (75.49) | 2.652 | (67.36) |
| 19 | 38 | 3.248 | (82.50) | 3.289 | (83.54) | 3.244 | (82.40) | 3.274 | (83.16) | 3.108 | (78.94) | 3.128 | (79.45) | 2.808 | (71.32) |
| 20 | 40 | 3.404 | (86.46) | 3.445 | (87.50) | 3.400 | (86.36) | 3.430 | (87.12) | 3.264 | (82.91) | 3.284 | (83.41) | 2.964 | (75.29) |
| 21 | 42 | 3.560 | (90.42) | 3.601 | (91.47) | 3.556 | (90.32) | 3.586 | (91.08) | 3.420 | (86.87) | 3.440 | (87.38) | 3.120 | (79.25) |
| 22 | 44 | 3.716 | (94.39) | 3.757 | (95.43) | 3.712 | (94.28) | 3.742 | (95.05) | 3.576 | (90.83) | 3.596 | (91.34) | 3.276 | (83.21) |
| 23 | 46 | 3.872 | (98.35) | 3.913 | (99.39) | 3.868 | (98.25) | 3.898 | (99.01) | 3.732 | (94.79) | 3.752 | (95.30) | 3.432 | (87.17) |
| 24 | 48 | 4.028 | (102.31) | 4.069 | (103.35) | 4.024 | (102.21) | 4.054 | (102.97) | 3.888 | (98.76) | 3.908 | (99.26) | 3.588 | (91.14) |
| 25 | 50 | 4.184 | (106.27) | 4.225 | (107.32) | 4.180 | (106.17) | 4.210 | (106.93) | 4.044 | (102.72) | 4.064 | (103.23) | 3.744 | (95.10) |
| 26 | 52 | 4.340 | (110.24) | 4.381 | (111.28) | 4.336 | (110.13) | 4.366 | (110.90) | 4.200 | (106.68) | 4.220 | (107.19) | 3.900 | (99.06) |
| 27 | 54 | 4.496 | (114.20) | 4.537 | (115.24) | 4.492 | (114.10) | 4.522 | (114.86) | 4.356 | (110.64) | 4.376 | (111.15) | 4.056 | (103.02) |
| 28 | 56 | 4.652 | (118.16) | 4.693 | (119.20) | 4.648 | (118.06) | 4.678 | (118.82) | 4.512 | (114.60) | 4.532 | (115.11) | 4.212 | (106.98) |
| 29 | 58 | 4.808 | (122.12) | 4.849 | (123.16) | 4.804 | (122.02) | 4.834 | (122.78) | 4.668 | (118.57) | 4.688 | (119.08) | 4.368 | (110.95) |
| 30 | 60 | 4.964 | (126.09) | 5.005 | (127.13) | 4.960 | (125.98) | 4.990 | (126.75) | 4.824 | (122.53) | 4.844 | (123.04) | 4.524 | (114.91) |
| 31 | 62 | 5.120 | (130.05) | 5.161 | (131.09) | 5.116 | (129.95) | 5.146 | (130.71) | 4.980 | (126.49) | 5.000 | (127.00) | 4.680 | (118.87) |
| 32 | 64 | 5.276 | (134.01) | 5.317 | (135.05) | 5.272 | (133.91) | 5.302 | (134.67) | 5.136 | (130.45) | 5.156 | (130.96) | 4.836 | (122.83) |
| 33 | 66 | 5.432 | (137.97) | 5.473 | (139.01) | 5.428 | (137.87) | 5.458 | (138.63) | 5.292 | (134.42) | 5.312 | (134.92) | 4.992 | (126.80) |
| 34 | 68 | 5.588 | (141.94) | 5.629 | (142.98) | 5.584 | (141.83) | 5.614 | (142.60) | 5.448 | (138.38) | 5.468 | (138.89) | 5.148 | (130.76) |
| 35 | 70 | 5.744 | (145.90) | 5.785 | (146.94) | 5.740 | (145.80) | 5.770 | (146.56) | 5.604 | (142.34) | 5.624 | (142.85) | 5.304 | (134.72) |
| 36 | 72 | 5.900 | (149.86) | 5.941 | (150.90) | 5.896 | (149.76) | 5.926 | (150.52) | 5.760 | (146.30) | 5.780 | (146.81) | 5.460 | (138.68) |
| 37 | 74 | 6.056 | (153.82) | 6.097 | (154.86) | 6.052 | (153.72) | 6.082 | (154.48) | 5.916 | (150.27) | 5.936 | (150.77) | 5.616 | (142.65) |
| 38 | 76 | 6.212 | (157.78) | 6.253 | (158.83) | 6.208 | (157.68) | 6.238 | (158.45) | 6.072 | (154.23) | 6.092 | (154.74) | 5.772 | (146.61) |
| 39 | 78 | 6.368 | (161.75) | 6.409 | (162.79) | 6.364 | (161.65) | 6.394 | (162.41) | 6.228 | (158.19) | 6.248 | (158.70) | 5.928 | (150.57) |
| 40 | 80 | 6.524 | (165.71) | 6.565 | (166.75) | 6.520 | (165.61) | 6.550 | (166.37) | 6.384 | (162.15) | 6.404 | (162.66) | 6.084 | (154.53) |
| 41 | 82 | 6.680 | (169.67) | 6.721 | (170.71) | 6.676 | (169.57) | 6.706 | (170.33) | 6.540 | (166.12) | 6.560 | (166.62) | 6.240 | (158.50) |
| 42 | 84 | 6.836 | (173.63) | 6.877 | (174.68) | 6.832 | (173.53) | 6.862 | (174.29) | 6.696 | (170.08) | 6.716 | (170.59) | 6.396 | (162.46) |
| 43 | 86 | 6.992 | (177.60) | 7.033 | (178.64) | 6.988 | (177.50) | 7.018 | (178.26) | 6.852 | (174.04) | 6.872 | (174.55) | 6.552 | (166.42) |
| 44 | 88 | | | | | | | 7.174 | (182.22) | | | 7.028 | (178.51) | 6.708 | (170.38) |

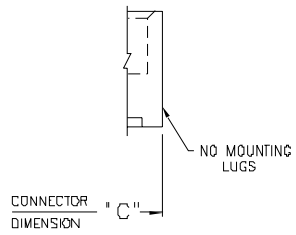


# MOUNTING OPTIONS - CARD EDGE CONNECTORS

Standard Mounting Details

## CODE x01 - NO MOUNTING LUGS

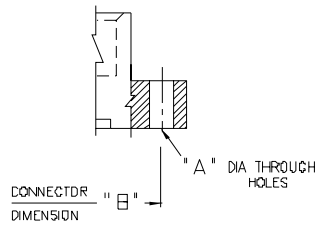
- Applicable for 303, 305, 306, 307, 310, 315, 316, 317, 321, 325, 327, 333, 336, 337, 338, 340, 341, 342, 345, 346, 355, 356, 357, 379, 384, 387, 391, 392, 395 and 396 Series




MOUNTING OPTION
CODE x01

## CODE x02, x04 & x09 - THROUGH MOUNTING HOLES

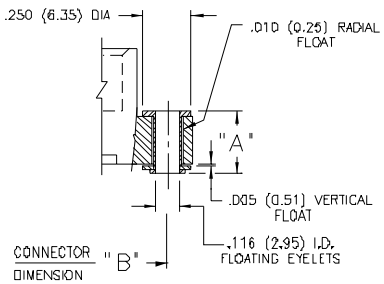
| Applicable Series | Code x02 "A" Dia. | Code x04 "A" Dia. | Code x09 "A" Dia. |
|---|---|---|---|
| 303, 305, 306, 307, 310, 315, 316,321, 333, 337, 338, 340 341, 345,346, 355, 356, 357 379, 384, 387,391, 395, 396 | .128 (3.25) | .156 (3.96) | — |
| 317, 323 | .144 (3.66) | .156 (3.96) | — |
| 325 | — | — | .160 (4.06) |
| 327 | — | — | .163 (4.14) |
| 336 | .128 (3.25) | .156 (3.96) | .178 (4.52) |
| 342, 392 | .128(3.25) x .146 (3.71) Slot | .156 (3.96) | — |




MOUNTING OPTION
CODES x02, x04 & x09

## CODE x03 - FLOATING EYELETS

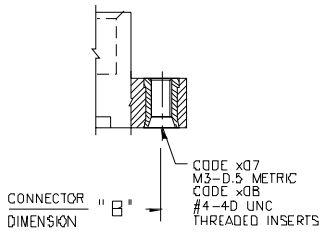
| Applicable Series | "A" |
|---|---|
| 303, 305, 306, 307, 310, 315, 316, 317, 321, 323, 333, 336, 337, 338, 341, 345, 346, 355, 356, 357, 379, 384, 387, 391, 395, 396 | .328 (8.33) |
| 342, 392 | .348 (8.84) |




MOUNTING OPTION
CODE x03

## CODE x07 & x08 - THREADED INSERTS

- Applicable for 303, 305, 306, 307, 310, 315, 316, 317, 321, 323, 325, 333, 336, 337, 338, 341, 342, 345, 346, 356, 357, 379, 384, 387, 391, 392, 395 and 396 Series
- See Code x12 for Side Mounting Threaded Inserts

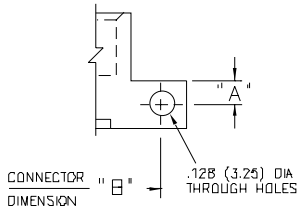



MOUNTING OPTION
CODES x07 & x08

## CODE x12 - SIDE MOUNTING HOLES

| Applicable Series | "A" |
|---|---|
| 307, 333, 337, 345, 346, 357, 387, 395, 396 | .125 (3.18) |
| 342, 392 | .135 (3.43) |

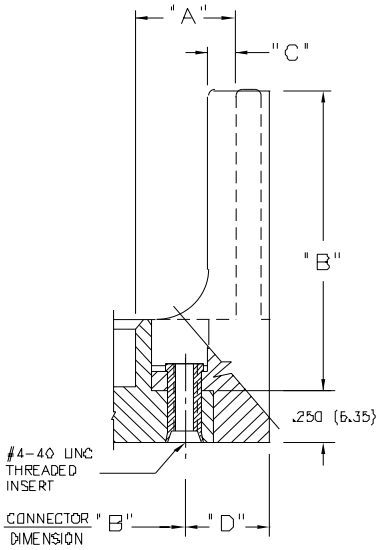
- Series Listed Above based on Availability of 90 Degree Bend Contact Tails. Side Mounting Holes may also be Used for Other Card Edge Connectors with a Lug Height of .250 (6.35) or Greater.
- For Side Mounting with Threaded Inserts, Specify Code x17 for M3-0.5 Metric Threads or Code x18 for #4-40 Unified Threads.




MOUNTING OPTION
CODE x12



Tel: (416) 754 - 3322



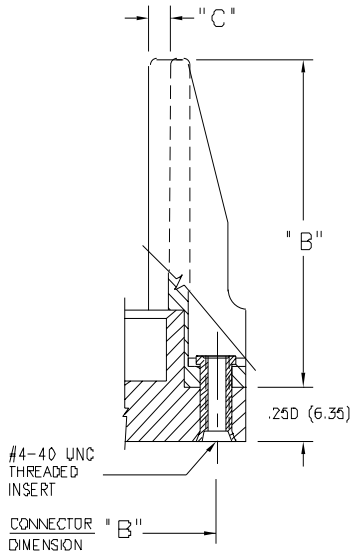

MOUNTING OPTION
CODES x58 & x68

## CODE x58 & x68 - OFFSET CARD GUIDES

| Applicable Series for Code x58 Guides | "A" | "B" | "C" | "D" |
|---|---|---|---|---|
| 305, 306, 307, 315, 316, 337, 338, 355, 356, 357, 387 | .468 (11.89) | 2.755 (69.98) | .125 (3.18) | .423 (10.74) |
| 345, 395 | .468 (11.89) | 2.755 (69.98) | .120 (3.05) | .402 (10.21) |
| 346, 396 | .468 (11.89) | 2.755 (69.98) | .120 (3.05) | .398 (10.11) |

| Applicable Series for Code x68 Guides | "A" | "B" | "C" | "D" |
|---|---|---|---|---|
| 305, 306, 307, 315, 316, 337, 338, 355, 356, 357, 387 | .344 (8.74) | 2.505 (63.63) | .060 (1.52) | .242 (6.15) |

- For Card Guides with .128 (3.25) Dia. Through Hole Inserts, Specify Code x52 or x62.
- For Card Guides with M3-0.5 Metric Threaded Inserts, Specify Code x57 or x67.
- For Field Assembly of Card Guides, Refer to Page 71.




MOUNTING OPTION
CODES x78 & x88

## CODE x78 & x88 - IN-LINE CARD GUIDES

| Applicable Series for Code x78 Guides | "B" | "C" |
|---|---|---|
| 305, 306, 307, 315, 316, 337, 338, 355, 356, 357, 387 | 1.550 (39.37) | .090 (2.29) |
| 317 | 1.712 (43.48) | .110 (2.79) |
| 345, 395 | 2.750 (69.85) | .083 (2.11) |
| 346, 396 | 2.750 (69.85) | .091 (2.31) |

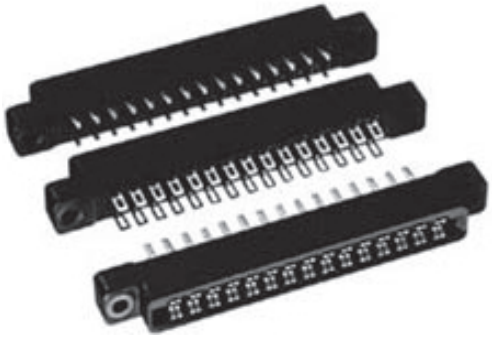
| Applicable Series for Code x88 Guides | "B" | "C" |
|---|---|---|
| 345, 395 | 1.250 (31.75) | .083 (2.11) |

- In-Line Card Guides are Not Suitable for the Flush Mounting Lug Versions of 337, 387, 346 or 396 Series
- For Card Guides with .128 (3.25) Dia. Through Hole Inserts, Specify Code x72 or x82.
- For Card Guides with M3-0.5 Metric Threaded Inserts, Specify Code x77 or x87
- For Field Assembly of Card Guides, Refer to Page 71.

# EB8

Vishay Dale

# Edgeboard Connectors, Dual Readout



## FEATURES

- 0.156" C-C x 0.200" grid [3.96mm x 5.08mm].
- Greater design latitude.
  3 body materials: Diallyl phthalate, phenolic and glass-filled polyester.
  6 contact termination styles.
  8 body sizes.
  7 mounting styles.
- Bifurcated bellows contacts provide 2 flexing contact surfaces to assure positive contact.
- Accepts PC board thickness of 0.054" - 0.071" [1.37mm -1.80mm].
- Polarization between contact positions in all sizes.
- Selective gold plating.
- **Recognized under the Component Program of Underwriters Laboratories, Inc. Listed under File E65524, Project 77CH3889.**

## APPLICATIONS

For use with 0.062" [1.57mm] printed circuit boards requiring an edgeboard type connector on .156" [3.96mm] centers.

## PHYSICAL SPECIFICATIONS

**Contact Type:** Bifurcated bellows.
**Number of Contacts:** 6, 10, 12, 15, 18, 22, 24, 25 per side.
**Contact Spacing:** 0.156" [3.96mm] center to center.
**Card Thickness:** 0.054" to 0.071" [1.37mm to 1.80mm].
**Card Slot Depth:** 0.330" [8.38mm], dual readout.

## MATERIAL SPECIFICATIONS

**Body:**
"1" glass-filled diallyl phthalate per MIL-M-14, Type SDG-F green, flame retardant (UL 94V-0).
"2" glass-filled phenolic per MIL-M-14, Type MFH dark green, flame retardant (UL 94V-0).
"3" thermoplastic polyester, glass-filled, black, flame retardant (UL 94V-0).
"5" thermoplastic polyphenylene sulfied, glass-filled, brown, flame retardant (UL 94V-0).
**Contacts:** Phosphor bronze.
**Polarizing Key:** Glass reinforced nylon, flame retardant (UL 94V-O).
**Contact Plating:** Gold (See Ordering Information).

**NOTE:** High temperature burn-in, edgeboard connectors, 0.156" [3.96mm] center to center are on page 20 of this catalog.

## ELECTRICAL SPECIFICATIONS

**Current Rating:** 5 amps.

**Test Voltage Between Contacts:**

At sea level: 1800VRMS.

At 70,000 feet [21,336 meters]: 450VRMS.

**Insulation Resistance:** 5000 Megohm minimum at 500VDC potential.

**Contact Resistance:** 30 millivolts maximum at rated current (with gold plating).

**Operating Temperature:** - 55°C to + 125°C.

**Humidity:** 96 hours at 90% relative humidity at + 40°C, dried at room temperature for 3 hours minimum, insulation resistance 5000 Megohm.

**Durability:** (With gold plating.) After 500 cycles of insertion and withdrawal of 0.070" [1.78mm] thick steel test gauge, contact resistance less than 0.030V at 5 amps and individual contact retention force when measured with a 0.054" [1.37mm] thick steel test pin greater than 1/2 ounce.

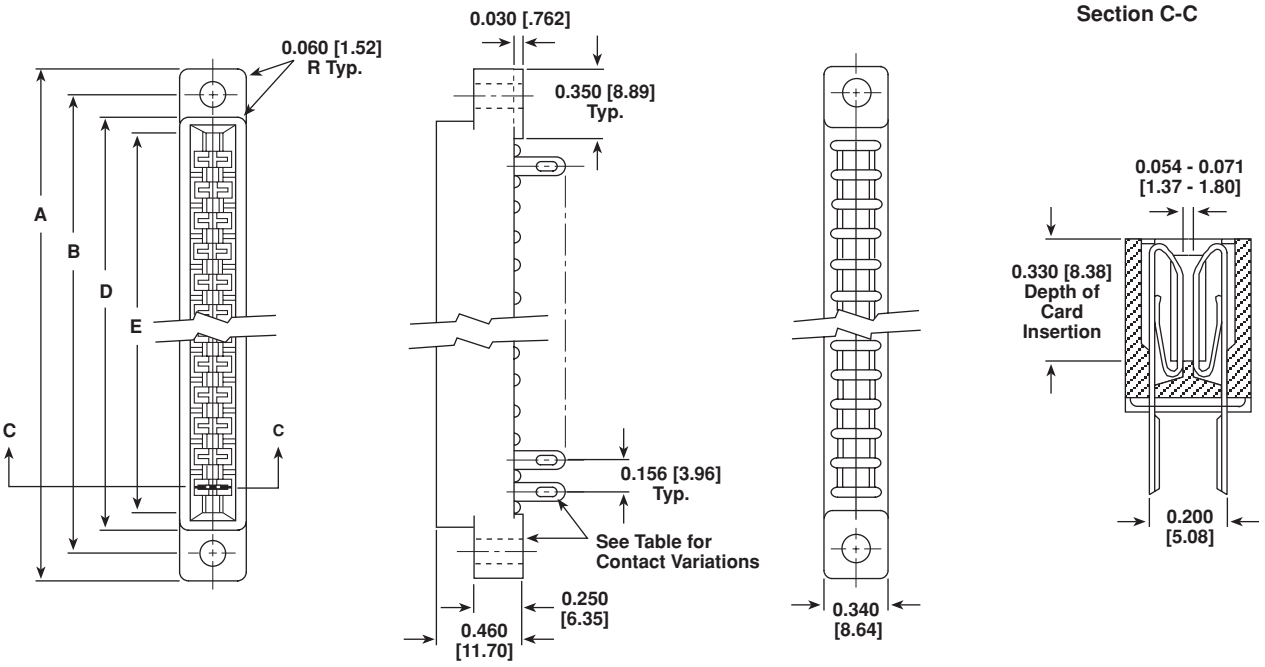
**Shock:** Three 50g shocks in each of 3 mutually perpendicular planes with no loss of continuity.

**Vibration:** 2 hours in each of 3 mutually perpendicular planes, frequency sweep 10 to 55cps at 0.06 double amplitude with no loss of continuity.

## ORDERING INFORMATION

| EB8 | 1 | B | A | 22 | SG | X | A |
|---|---|---|---|---|---|---|---|
| MODEL | BODY MATERIAL | OPTIONAL CONTACTS | STANDARD TERMINAL VARIATIONS | CONTACTS | CONTACT PLATING | MOUNTING VARIATIONS | POLARIZING KEY POSITIONS |
| | Optional Body Material<br>1 = Diallyl Phthalate<br>2 = Phenolic<br>3 = Glass-filled Polyester<br>5 = Glass-filled Polyphenylene Sulfied | Beryllium Copper contacts optional. Available in "A" and "E" contact styles only. (Omit for standard.) | A, C, D, K, L or E | 6, 10, 12, 15, 18, 22, 24 or 25 | SG = Selective Gold Plating (0.00003" [0.000762mm] minimum thick) on contact area with Gold Flash on terminal.<br>SGF = Selective Gold Plating (0.00001" [0.000254mm] minimum thick) on contact area with Gold Flash on terminal.<br>All Gold Plating over 0.00005" [0.00127mm] minimum Nickel Underplate.<br>Contact factory for additional plating options. | | Key(s) are located to right of position(s) designated. Required only when polarizing keys are to be factory installed. |

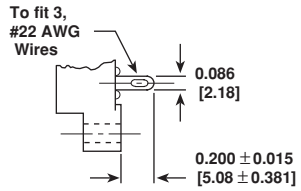
## DIMENSIONS in inches [millimeters]



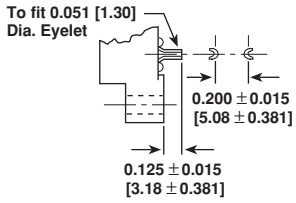

| # OF CONTACT POSITIONS | A | B | D | E |
|---|---|---|---|---|
| 6 | 1.78 [45.21] | 1.531 [38.89] | 1.240 [31.50] | 1.100 [27.94] |
| 10 | 2.41 [61.21] | 2.156 [54.76] | 1.864 [47.35] | 1.724 [43.79] |
| 12 | 2.72 [69.09] | 2.469 [62.71] | 2.176 [55.27] | 2.036 [51.71] |
| 15 | 3.19 [81.03] | 2.937 [74.60] | 2.644 [67.16] | 2.504 [63.60] |
| 18 | 3.66 [92.96] | 3.406 [86.51] | 3.112 [79.05] | 2.972 [75.49] |
| 22 | 4.28 [108.71] | 4.031 [102.39] | 3.736 [94.89] | 3.596 [91.34] |
| 24 | 4.59 [116.59] | 4.344 [110.33] | 4.051 [102.89] | 3.911 [99.34] |
| 25 | 4.75 [120.65] | 4.500 [114.30] | 4.207 [106.86] | 4.067 [103.30] |

## TERMINAL VARIATIONS in inches [millimeters]

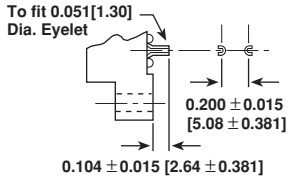
**Type "A" Pierced**



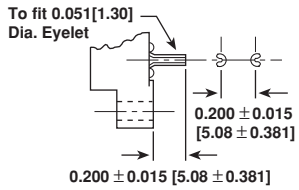

**Type "C"**



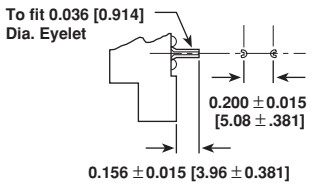

**Type "D" Solder Dip**




**Type "K" Solder Dip**

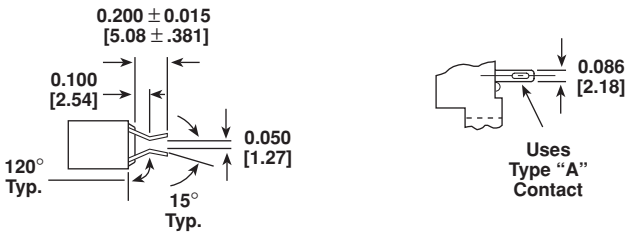



**Type "L" SolderDip**

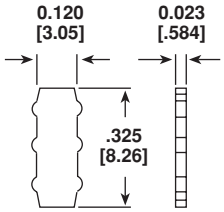


## TERMINAL VARIATIONS in inches [millimeters]

**Type "E"**
**Card Extender**



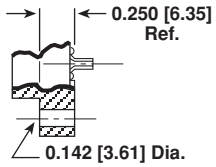

## POLARIZING KEY



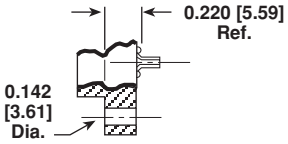

When ordering polarizing keys individually, specify Model Number: PK-8 between contacts.
Hand insertion tool, TPK-8, provided on request.

## MOUNTING VARIATIONS in inches [millimeters]

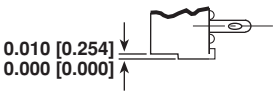
**Type "V"**
**Clearance Hole**



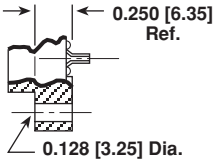

**Type "VI"**
**Clearance Hole**
**No Mounting Pad**



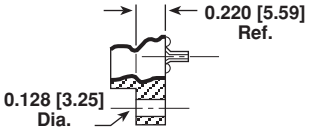

**Type "W"**
**No Mounting Flange**



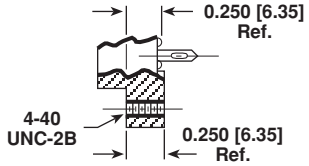

**Type "X"**
**Clearance Hole**



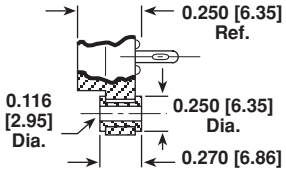

**Type "XI"**
**Clearance Hole**
**No Mounting Pad**




**Type "Y"**
**Threaded Insert**




**Type "Z"**
**Floating Bushing Radial Float 0.047 [1.19]**




**NOTE:** Overall body length increased by 0.060 [1.52].

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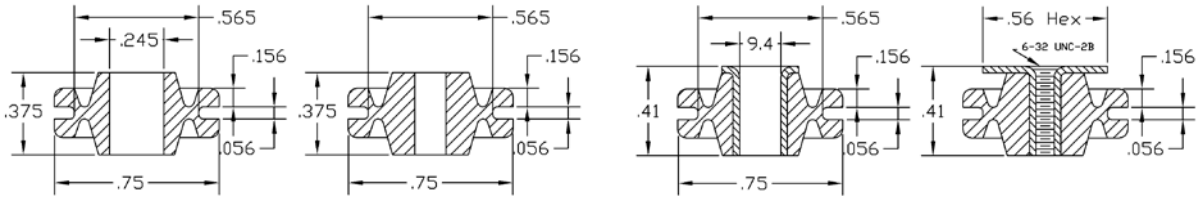
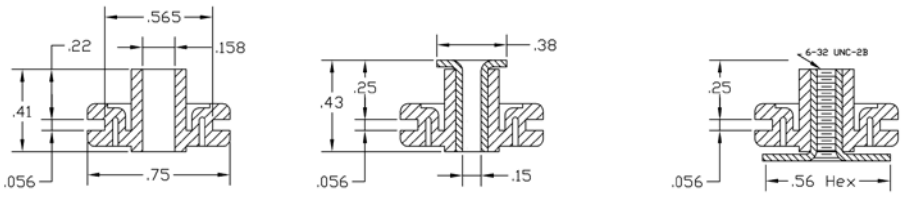
## J3112 SERIES



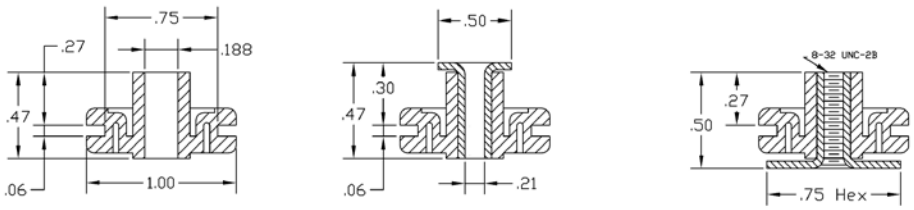

| Part Number | Figure | Elastomer | Maximum Axial Load | | Deflection | | Axial Spring Rate | | Radial Spring Rate | | Support Member Thickness | | Support Member Diameter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lbs | N | in | mm | lbs/in | N/mm | lbs/in | N/mm | in | mm | in | mm |
| **J311251** | 1a | Natural | 1 | 4 | 0.045 | 1.2 | 22 | 3.9 | 44 | 7.7 | 0.062 | 1.6 | 0.555 | 14.1 |
| **J3112611** | 1d | Natural | 1 | 4 | 0.045 | 1.1 | 22 | 3.9 | 44 | 7.7 | 0.062 | 1.6 | 0.555 | 14.1 |
| **J311222** | 1b | Neoprene | 2 | 9 | 0.060 | 1.5 | 33 | 5.8 | 66 | 11.6 | 0.062 | 1.6 | 0.555 | 14.1 |
| **J3112802** | 1c | SPE | 2 | 9 | 0.035 | 0.9 | 57 | 10.0 | 114 | 20.1 | 0.062 | 1.6 | 0.555 | 14.1 |
| **J311283** | 1c | Neoprene | 3 | 13 | 0.060 | 1.5 | 50 | 8.8 | 100 | 17.5 | 0.062 | 1.6 | 0.555 | 14.1 |
| **J3112804** | 1c | SPE | 4 | 18 | 0.035 | 0.9 | 114 | 20.1 | 228 | 40.2 | 0.062 | 1.6 | 0.555 | 14.1 |

## J17736 SERIES




| Part Number | Figure | Elastomer | Maximum Axial Load | | Deflection | | Axial Spring Rate | | Radial Spring Rate | | Support Member Thickness | | Support Member Diameter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lbs | N | in | mm | lbs/in | N/mm | lbs/in | N/mm | in | mm | in | mm |
| **J177362** | 2c | Neoprene | 1 | 4 | 0.060 | 1.5 | 17 | 2.6 | 17 | 2.6 | 0.062 | 1.6 | 0.555 | 14.1 |
| **J1773641** | 2c | SPE | 1 | 4 | 0.060 | 1.5 | 17 | 2.6 | 34 | 5.3 | 0.062 | 1.6 | 0.555 | 14.1 |

## J2924 / J2927 SERIES




| Part Number | Figure | Elastomer | Maximum Axial Load | | Deflection | | Axial Spring Rate | | Radial Spring Rate | | Support Member Thickness | | Support Member Diameter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | lbs | N | in | mm | lbs/in | N/mm | lbs/in | N/mm | in | mm | in | mm |
| **J292421** | 3a | | 1 | 4 | 0.006 | 1.5 | 17 | 2.6 | 17 | 2.6 | 0.062 | 1.6 | 0.735 | 18.7 |
| **J2927461** | 3c | Neoprene | 1 | 4 | 0.060 | 1.5 | 17 | 2.6 | 17 | 2.6 | 0.062 | 1.6 | 0.735 | 18.7 |
| **J292714** | 3b | Neoprene | 4 | 18 | 0.060 | 1.5 | 65 | 11.4 | 65 | 11.4 | 0.062 | 1.6 | 0.735 | 18.7 |